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JACQUARD, THE INVENTOR.

THE history of human endeavor has certainly neither more curious nor pitiful a romance of ruin and recompense than that of Joseph Marie Jacquard. Bankrupt in purse, driven from his home, his house burned, a common soldier under an assumed name in the army of the Rhine, his son shot dead by his side, his wife earning a scanty subsistence by straw weaving or at washing, mobbed by his neighbors and compelled to hide himself among the lime burners of Bresse, the day came when he wore the cross of the Legion of Honor, held a government position, enjoyed a pension and a royalty on his invention, when his statue from the chisel of Foyatier stood the chief ornament of his native city, and Alphonse de Lamartine included his biography among those of the fourteen he deemed worthy to be called *grands hommes*.

JOSEPH MARIE JACQUARD.

Joseph Marie Jacquard was born at Lyons in 1752. His father, who had come from a stone quarry to learn silk weaving, died young and left his son an inheritance of two rude looms. The boy, already of a restless spirit, had been successively apprenticed to a book binder, a cutler, and a type founder, and with each showed ability and ingenuity. Jacquard was an inventor from the beginning. Standing in the cutlery shop of a friend one day, he noticed that a knife blade passed through three or four hands before it was ready for the handle. He looked silently on until asked, "What are you thinking of?"

"You will see to-morrow," was the answer.

And the next day he laid before his astonished friend the drawing of a machine which would in five minutes do the work which then occupied four men an hour. His friend was too poor to build the machine, even if his workmen would have allowed it to be operated.

Meanwhile Jacquard met with poor success in his business. His time and his money were given to the perfection of the great idea which had filled his mind to the exclusion of everything else. He exhausted his means and was even obliged to sell his shop and his looms. At last he hid himself among the lime burners at Bresse, while his wife earned a precarious existence for herself and child by weaving straw bonnets. There are few records of his whereabouts or doings for the next fifteen years, but when the French revolution came he was with the revolutionists in their fierce defense of Lyons against the armies of the convention.

With the capture of the city he was again obliged to fly, himself proscribed and his house burned, but was saved by his son, then a boy of fifteen, who gave him a uniform, and side by side they marched in the army of the Rhine. The death of his son disheartened him for fighting, and he went back to Lyons and worked with his wife at straw weaving.

In 1801 an English society offered a prize for a machine which would simplify the weaving of nets for fishing and for use on ships. Jacquard saw the advertisement and constructed such a machine. It involved the principle later applied and still used in the manufacture of Nottingham laces. It was received by his friends with astonishment, and Jacquard was called upon to show it to the prefect of police; but machinery—except that for killing men—was not fashionable in those days, and it lay neglected for months, when in some way it came to the notice of Napoleon, and the prefect was ordered to send the inventor to Paris.

The frightened official hastened to arrest the unfortunate Jacquard, and he was sent closely guarded by soldiers to the great First Consul. Here he was met by the famous war minister, Carnot, with the exclamation: "So you're the fellow that pretends to do what's impossible—tie a knot in a tight string."

Jacquard, however, explained the miracle, repaired his broken machine and in a few days satisfied the doubters of his ability to do what he claimed. He was given a gold medal and the office of examining and repairing the models in the *Conservatoire des Arts et Metiers*—the French Patent Office. Here he saw Vaucanson's great loom, and years after some of those cheerful pirates who delight in nailing the black flag to every great reputation, charged that he took valuable ideas from his predecessor—an idle lie and one easily discomfited.

Nevertheless, the presence of all these models did stimulate him to renewed endeavor, and late in 1801 he had completed a machine which would make figured goods at much less cost than was then possible, and exhibited at the exposition. Napoleon, keenest of conquerors, saw at once the value to France of the great invention, and awarded Jacquard a pension of 6,000 frs., while the jury only gave him a bronze medal—"the inventor," they said, "of a machine by means of which one workman less would be required in the fabrication of brocaded tissues." On one of his own looms and with his own hands he wove a robe of magnificent brocaded silk for the Empress Josephine, and then, triumphant, returned to Lyons in 1804, his invention now an accomplished fact.

A machine which at once abolished the draw boy, deprived one or two persons on every loom of their employment, and condemned to idleness one-half the people engaged in the great industry of Lyons, met with no favor at the hands of the populace. The silk weavers denounced him bitterly as a traitor, and mobbed him when he appeared upon the streets. On one occasion he was with difficulty rescued from the hands of a crowd of starving weavers who intended to drown him. At last he fled from the city. The popular clamor was so great that the authorities at Lyons were obliged, in order to satisfy the populace, to order the destruction of his loom in the public square of the city, and in the presence of a vast assemblage it was smashed to pieces, the iron, as Jacquard himself wrote, being sold for old iron and the wood for fuel.

Slowly, however, the business was increased by the introduction of new looms. Draw boys became weavers and weavers owners of shops. All over the world the invention was adopted with avidity, and France began to feel the competition. Then the revulsion came and the Lyonnais in turn abused the authorities whom they had incited to destroy the machine.

From that moment life was easy for Joseph Jacquard, but his wife and child were dead and he was an old man. Fifteen years before he died, however, he had the satisfaction of seeing a jury of his countrymen reverse the stupid action of a similar jury a few years before, and with the award of a gold medal received the cross of the Legion of Honor. The last years of his life were passed in a little village in the suburbs of Lyons, where he was visited by many of the great men of his day. His days passed peacefully, his time being occupied in the care of his garden, and he died in August, 1834, at the age of eighty-four. He was buried beside Thomas, the poet and French academician, but it was long before his native city fairly woke to a recognition of the boon he had conferred upon it, and six years elapsed before his statue was erected in La Place Sathony.—*The Mercer.*

THE WHITENING OF WOOL.

WE owe to M. Hofmann, of Dresden, an interesting communication on the process employed for producing a pure white on wool. It is well known that it is impossible, even by the aid of the most active bleaching agents, to remove from the wool a faint shade of yellow, which becomes specially noticeable when the material is contrasted with silk or cotton.

The neutralization of this yellow by a complementry blue, such as is used for cotton, linen, paper, etc., only gives poor and unsatisfactory results. Attempts have long been made to give wool a better white by means of white topping substances, such as magnesium carbonate. This method has had, however, to be given up on account of the dust formed after a short period of storage.

The author proposes to obtain a better result by vegetalizing the wool, that is to say by impregnating it with a solution of cuprous oxide in ammonia, and then passing the fiber into a solution of sugar or dilute acid, which precipitates the cellulose in an insoluble form, and thus fixes it. To render the gelatinous cellulose thus deposited opaque and white, the material is dipped into ether.

The same result is obtained by F. V. Hallah, by the use of hyposulphite (the old hydrosulphite) of soda and indigo. The effect produced is of two kinds: the hyposulphite produces decolorization by its energetic reducing action, and by dissolving the indigo mechanically deposited on the surface of the tissue, causes the coloring matter to penetrate uniformly into the fiber. The blue color is restored to the indigo by a subsequent exposure to the air, and being complementary to the yellow of the wool, completely destroys it. It is very doubtful whether, even under these conditions, a perfect equilibrium is attained between the yellow shade which is to be removed and the blue of the indigo. We have already observed that the numerous attempts previously made in this direction with various coloring matters have resulted in failure. However this may be,

the method, as given by the *Deutsche Farb. Zeit.*, is as follows:

The hyposulphite solution should be prepared immediately before use. For this purpose, seven parts of zinc dust, or 20 to 30 parts of granulated or sheet zinc, are digested with a concentrated solution of bisulphite of sodium, representing about 100 parts of the dry salt. The operation is carried on in a well closed vessel, which must be shaken up at intervals during an hour. The clear liquid is decanted, and contains hyposulphite of sodium, together with some of the zinc salt.

The woolen material, carefully purified, washed, and freed from fat, etc., is thoroughly moistened in a bath of cold water, in which indigo is suspended in a very fine state of division. The best quality for the purpose is that which gives bright blues of a reddish shade in the vat process. The material emerges from the bath covered over with particles of indigo deposited on the surface.

It is then passed into the bleaching solution, which is composed of water and hyposulphite solution at 1°–4° Baume. Just before passing in the material a quantity of acetic acid equivalent to the hyposulphite present is added. It is essential that the stuff be properly manipulated, so that the reduction of the indigo proceeds with perfect regularity.—*Le Mon. de la Teinture.*

THE TELEPHONE GIRL: HER EVOLUTION, HER CHARACTERISTICS AND HER WORK.

By Nell Nelson.

There is caste even among the blithesome little shop girls, and from what Mr. Howells calls "the signs of the times," there are reasons for thinking that electricity is a force strong enough to establish the identity of the Brahmins of the society of working women.

The telephone girl, like the lead pencil maker, is an operator, but their affiliation is a social impossibility. Fifth Avenue and Avenue D are not more remote. And why should not the heroine of the head telephone flaunt her tidy skirts, square her pretty shoulders and smile loftily, if a trifle scornfully, at those other girls in the street cars and ferry boats?

There are no basting stitches hanging to her garments, there is no fluff of the work room in her hair, nor does she carry about her the scent of chemicals or the fumes of tobacco. She does not have to wear a black jersey waist and an alpaca skirt—the garb of the dry goods clerk—or go about with heelless shoes. She is as free as a society belle to wear what she likes, and to save your life you cannot class her with any trade in the field of labor. She is not a shop girl, a factory girl or a clerk, and she will not be called a "hand." Ask her what she does for a living, and she will stun you for a moment with a forbidding "I beg your pardon." She does not work. She is employed by the Metropolitan Telephone Company, and were you ever so bright an amateur photographer, you could not catch her with a kodak. She is proud, independent and capable, and she has the instincts of a true woman.

She gets her position, not through the columns of a daily paper, but through the influence of a brother or family friend, employed by the company in one of its many departments. He vouches for her intelligence, respectability and judgment; she is registered on the list of applicants and appointed to the first vacancy. There is an exclusiveness about the whole arrangement that is most admirable, and as a result, places are in demand, and the superintendent has a reserve force of very select material from which to re-enforce his staff.

The telephone girl may not be educated, but she must be nice, as they say in the South, and must be possessed of a medium grade of intelligence. She must be able to write a letter, make a clear statement in good English, hold her tongue, keep her temper under every provocation, and give her undivided attention to the business of the office. Any defect in speech or hearing would necessarily disqualify her for the work. Tact and judgment are indispensable, and lacking one or the other she will break down in a very short time, for nothing so quickly develops a pugnacious tendency as service at a public telephone. Fifteen years ago, when the instrument was introduced for general service, the telephone companies employed boys between the ages of 16 and 19, with results that were first disturbing, then discouraging, and finally threatened to be destructive to the interests of the company. Incessant and emphatic stress was laid upon the necessity for absolute civility of speech on the part of the boys. Terms of expression were reduced to the soul of brevity, so that the language of the office was humorously monosyllabic, and all conversation over the wires was prohibited. Rules in letters of belligerent hue and formidable size were posted in conspicuous places, forbidding the operator to add a syllable more than was necessary to answer the subscriber's question. As a further means of preserving harmony and protecting business interests, monitor operators were stationed in every section to lend ear to the sayings and doings of the boys.

But the average boy is no respecter of persons, and when an irritable money bag or a crusty old bank president, impatient of delay, and wholly ignorant of the war among the wires, was so forgetful of *richesse oblige* as to dilate on "infernal" things, "lazy puppy" and the like, the impulsive youth quietly but distinctly told the opulent old party to take himself to the place Col. Ingersoll says "is not." Such flagrant violations of the rules resulted in immediate dismissal; but notwithstanding, similar offenses were of daily occurrence and necessitated the employment of a relay force as large as the original staff of operators.

Everything that could be done by the company to inculcate a spirit of forbearance was done; but boys will be boys, and unable to knock down the man at the other end who gave them any "sass," they gleefully blew him up and took the consequences. To employ the services of men of mature judgment and business sagacity would have entailed greater expense than the corporation cared to stand, and as a last resort what was deemed a risky experiment was tried; the telephone girl was introduced.

At first she was an old girl, quiet, sedate and thoughtful, with a knowledge of human nature acquired through lost youth and the scars of experience. She came in modest gray and melancholy black. Her ways were kittenish and also motherly. She brought a piece of soap, a piece of comb and a piece of looking glass, done up in a paper box. Under the influence of her gentle presence at the switch board, her fingers at the plugs and cords, her lips at the transmitter and her ear at the telephone, discord dropped to a minimum. There was no more swearing or blowing up, no "back talk" and no serious complaints or threats on the part of subscribers to withdraw patronage; but the service was still but a mediocre success. The girls were stiff. They lacked malleability and flexibility. They did not seem able to adapt themselves to the requirements. By degrees, sprightly girlish girls were taken on the force, also as an experiment, and they "caught on" so readily and swung into line so naturally that all unconsciously they solved the problem of efficient telephone service. From that time the decline of telephone widows and old maids began, and a decided preference was shown for girls less than 25 and more than 16 years of age.

Oddly enough, the first objection to woman service came from the very men who had lodged the greatest number of complaints against the cheeky boy operators. They very forcibly urged that without a small boy or an office cat on which to vent his wrath, the average bondholder would go daft.

The same rules hold good to-day that governed the predecessors of the telephone girls, and enforced silence covers a multitude of sins. It does away entirely with a propensity for slang phrases or pert remarks, and is a barrier to chance acquaintances as well as to intrigue or flirtation. Every now and then one reads in the newspapers sensational paragraphs about "the frisky telephone girl" and the high roller "on 'change," but nothing could be further from the truth. Such paragraphs libel the girl and pay a compliment to the mercantile masher that he does not deserve. As a matter of fact, the young woman is as much a part of the instrument as it is possible for a human creature to become. She is a medium of conversation between two subscribers with just enough individuality to get them on a direct line of communication when required to do so.

"Hello?"
"What number?"
"There's number so and so."
"Are you through?"
"They're busy. I'll call you."
"Certainly."
"I'll try."
"Yes."
"546 doesn't answer."

There you have, with the slightest possible variation, almost the entire business language of the telephone girl.

To be sure, a subscriber can get any reasonable information he requires, as an accommodation, but not from the operator. She learns with a word of inquiry just what he wants and connects him with the manager of the office.

It used to be a very common practice for a scamp, a wag or a hobbledehoy to ring up central, for the purpose of having a little fun with the girl. He did not know, poor fool, that the operator would cut him off the moment he opened his mouth. If she neglected to do so at once the monitor would do it for her, but in either case the would-be smart young man has a queer sensation when he realizes that his eloquence has been poured into a hole in the ground, or is throbbing in his own transmitter without means of escape. Being a subscriber, he is entitled to use the telephone as much as he likes and not one word of remonstrance will be made, but when he perverts the instrument to purposes for which it was not intended, he is interfering with the business of the office and is promptly set aside as a nuisance. Let him call up a subscriber five minutes later, and his ring will be answered immediately and his correspondent put in communication with him as though nothing had happened.

Subscribers who are weak enough to get profane are either switched off or turned over to the manager of the office, but it must be said in justice to the sex that this rarely occurs, not that the girls are angels, but man's sense of respect is innate.

So rigidly is the rule of silence on ultra-central topics enforced, that if a girl's own mother came to the telephone she would not think of talking to her about their private affairs. For occasions of this sort there is a private telephone in the office which the operator is at liberty to use, as soon as a relay can be called to take her place. But she understands that her time belongs to the office, and you may be certain that she will say what she has to say in a few words and a few moments.

In this private call the monitor has absolutely no interest. She is, however, concerned in all other matters, her business being to aid as much as possible the interests of the subscribers, which are the interests of the company. Unlike the forewoman in the shop, the factory or the workroom, she is not regarded in the light of an eavesdropper or a tyrant, and the relations existing between the hundreds of operators and the half dozen monitors are most amicable. If an operator's answers should have a double meaning or if there should be anything about her conduct to arouse suspicion, her usefulness to the company is ended. This fact is well understood. Complaints are unknown, intrigues unheard of, and better, purer lives than these telephone girls lead cannot be found among the army of working women.

Every girl has fifty subscribers to look after, and if each calls fifty times during the day—and many do that, and more—she makes the connections he requires. There is no such thing as back work or catching up to-morrow. Every moment has its occupation and things must go considerably faster than clock-work. If she cannot keep up, there will be a hitch, then a storm from a battery of ten or twenty drops, and the poor little operator, vanquished and feverish, will have to lay down her head telephone and give her chair to a quick-witted, cool-headed, experienced sister who can lead the race.

As a class the telephone girls possess more winsome characteristics than any other organization of women—certainly in the business world, if not in the social. They are, to an individual, good tempered, gentle, bright and nimble. Their ears are as sensitive as the instruments they operate, and their voices music to the senses. The majority of the people who buy telephone service are gentlemen, and it is perfectly surprising to notice the influence they exert on these responsive, if automatic, little women. There is frankness in their very manner; their utterances are straightforward, simple and positive, and they are singularly free from the affectations and "airs" of their sex and class. In the friendly exchange of courtesies over the wire they grasp the amenities which refine their simple lives.

It is not a mistake, at all, to call the telephone service a school, and it is a school of a very high order, however limited. In her first engagement with the delicately constructed instrument, the novice opens her mouth and yells. In trying to find out "what number you want" she pours into the transmitter a volume of sound large enough to furnish energy for a brass band. One would naturally suppose that the rotund quality of voice would prove exhausting and that in order to economize her forces she would, of her own accord, try a lower pitch. Such, however, is not the case, and she would go on screeching to the end of her telephone life if left to herself. She does not believe her instructor knows what he or she is talking about when told that the subscriber will hear perfectly if she speaks in a low tone. The assertion is repeated and reiterated forty or more times, and it is not until extreme measures are threatened that she is induced to cease shouting and to talk in a natural tone of voice.

These vocal explosions are peculiar, not only to new operators, but also to subscribers generally. The subscribers seem to entertain the idea that a telephone office is filled with heavy machinery, batteries and dynamos, and is as noisy as an engine room, whereas the truth is that their own private offices and counting rooms are not more quiet.

After a week's training the rasping tones change to liquid sounds that are more than musical. They are soft and low, and they have the cheer and glint of sunshine. If you ever notice the vocalization of the telephone girl you will find that there is a coquettish curve, a graceful swing and a buoyancy about her questions that are delicious. Whether she says "there they are," "busy now" or "what number," the sound rolls in the form of a line of grace. The positive, assertive answer, with a decided fall of the voice, is depressing in effect, often discouraging, and hence is not used. Habitual talking in this mellifluous crescendo and diminuendo becomes second nature, and officials declare they can pick out of any crowd or community the girls or the women who have done telephone service.

Strange as it may seem, there are auditory as well as optical delusions. Every subscriber has two or three girls in his mind whom he considers active and obliging. He has absolutely no means of knowing who they are, but he thinks he can tell them by their voices, and gets irritable when they are off duty. As an illustration, not long ago a telephone official had reason to call on a prominent subscriber who devoted considerable time to dilating on the efficiency of his girl. He lauded her to heights delightful and had thought of recommending her to a friend for a lucrative position. The case was reported to the manager, who, on investigation, found that the very knowing but well meaning gentleman was bewitched by the general sweetness of the telephone office voice. The line being a particularly light one had no regular operator, and as a general rule no less than ten different girls handled the wire in a day. But he knew "his girl" every time, which speaks well for the vocal system in use for training voices.

People generally labor under the impression that the work does violence to the sense of hearing, whereas in almost every instance there is just the opposite effect. There is not one case on record where good hearing has been impaired by the "head telephone," but there are on the contrary scores of instances where slight defects have been entirely overcome. More than that, frequent privileges are granted specialists in diseases of the ear in the treatment of patients. People very hard of hearing, placed at a telephone in the office, have been spoken to with perfect ease, and one semi-deaf man, who through the courtesy of the manager was permitted to call up every subscriber he knew or ever heard of in or about New York, remarked as he left the office, "Well, this machine beats the miracles in the New Testament."

Nearly every girl finds difficulty in hearing at first, but in a very short while this disappears, and her ear becomes so sensitive that she can hear sounds which to other people are inaudible. She is able to detect at once the meaning of various noises in the telephone, which the subscriber does not perceive at all, but which, subsequently, may put him to the annoyance of delay. Here it might be stated that the subscriber gains nothing and wastes a great deal of vocal energy when he speaks above a dinner table tone of voice. If the wires are crossed, the yell of the Fiji Islander will not aid him in getting the desired connection, while, if the electrical avenue is clear, the man at the other end and the girl in the central office can plainly hear his softest words. All that is needed is a clear tone, which may be vocal or aspirate. Again, the power of concentration is needed to facilitate the telephone service. This most people lack. They cannot close their ears to external sounds. Hence the custom of boxing or inclosing the instrument for convenience as much as for privacy.

In an office where 120 girl operators are required, eight boys are also employed, green young fellows as a class, whose work consists of the mechanical operation of making connections between the trunk wires running to different exchanges. These boys receive their orders by telephone from the operators and have no communication with the subscribers. No girls are employed on the night force. The exposure to such uncanny hours is considered undesirable by the company, and wisely so, although many girls apply for night work. As now existing, the girls' schedule of work is from 7 to 7, with three forces working nine hours each. The first goes on duty at 7 A. M. and leaves at 5 P. M.; the second, or full force, works from 8 till 6, and the small force from 9 till 7. There is half an hour for lunch, and each operator is allowed a relief or recess of 15 minutes in the morning and again in the afternoon. A vacation of one week is granted with pay; every second Saturday is a half holiday, and the girls are in every respect as well treated as college students.

No fines of any sort are imposed. The management

is directed on the principle that accidents are unavoidable, but that willful neglect of duty or abuse of privileges should not be turned to gain or tolerated. If a girl is ill, she is relieved from work, and if sickness causes her absence, it is excused. The company provides for the exclusive use of the operators a suite of five large rooms, entirely apart from the exchange. One is the toilet section, lined with marble basins and mirrors, and provided with all toilet requisites; adjoining is the dressing room filled with lockers, which are numbered to correspond with the sections in the office. Each girl has her own key to a depository for her wraps and rainy weather outfit. The dining room is large, airy, and cheerful, tiled in red and white, and furnished in oak, with accommodations for at least sixty diners. In one corner is an improved range that works like an electric lamp, surmounted by two mammoth urns of German silver that run streams of tea and coffee the entire day. A cook, who knows how to prepare these beverages as they should be prepared, is in charge, and her duty is to serve the girls all they care to drink at any hour of the day and without as much as a penny tip. Beyond is the reading room, finished in hard wood, furnished with comfortable chairs and provided with fashion papers, weekly publications, and magazines. Notwithstanding this intellectual pabulum, the majority of the girls, woman like, prefer to crochet, rickrack, feather stitch, and gossip. The prettiest room in the suite is the sick ward. There are soft rugs on the floor, willow couches about the room, slumber blankets to throw over the case of headache, and holland curtains on the windows to shut out the glare. The day I called, a girl with the toothache was coiled up on one of the couches fast asleep at the busiest hour of the whole twenty-four. A matron has charge of these apartments, a retired operator, who, in a hundred kind ways, makes the rough places a little easier to travel.

Salaries vary from $30 to $50 a month, beginning the very day the girl is engaged, although she may not be useful as an operator for a month or more. The girls who are able to take charge without assistance and attend to fifty wires receive $35. Monitors are master hands, and earn $12 a week. There is besides the regular staff a relay force, getting $1 a day, always on hand to facilitate matters when disasters, public excitement, or unusual events increase the business of the office to an extent that overtaxes the capacity of the regular force. At all times the operator is in close touch with the world, but a rush on a bank, a corner on 'change, the progress of a political campaign, or a big fire will set the electrical machinery pulsating with an increased nervousness. When, however, a railway accident occurs, or news of a shipwreck is received, the people become frenzied and the instrument throbs with excitement. Railway and steamship companies are in constant demand, and cause the heaviest business, but there is scarcely a minute in the whole day when the tragedies of life are not being carried across the wires that connect the newspaper offices, the police stations, and the charity hospitals with the world at large. An operator cannot lose her head. She must forget that she has one. She must sink her individuality, and become a part of the instrument she manipulates. Not only is she responsible for her own lines, but in case of accident or interruption she is obliged to pick up the plugs in her neighbor's section and handle the calls as they come in. Superior to every condition is the subscriber, the great unknown who must be obeyed.

Curious does not describe the interior of a large telephone office. It is prodigious. The extent of the work accomplished, by what seems like child's play, is not to be conceived by the uninitiated. No schoolroom was ever conducted with less friction, and no pupils were ever more orderly, amiable and industrious than these two hundred little women with their quaint coronets and busy hands, that seem to play with the plugs and switches and drops all day long. The room is in the form of the letter U, the switchboard extending in an unbroken wall the entire curve.

This board is divided into sections at which the girls are seated, on a platform twelve inches or so above the floor, almost shoulder to shoulder. Each operator is within reach of 6,000 spring jacks, through which all the lines pass, and she answers the calls of fifty subscribers.

When one subscriber wants another he rings his telephone bell and at the same instant the switchboard apparatus answers his call by letting fall an annunciator drop bearing his number. Then the operator picks up a plug which is attached to a flexible conductor, and inserts it in the spring jack corresponding in number to the drop which fell. This puts her in communication with the subscriber, and after being told what number he wants to communicate with, she inserts another plug connected with the first into the spring jack attached to the required line. The connection is then complete, and she has only to signal the subscriber asked for to call his attention. Her work is done, and any delay after that lightning-like process is due to the negligence of the subscriber in answering his bell. If the subscriber were one-twentieth part as alert as the operator, the question of quick service would solve itself. There would be an increase of harmony, a diminution of worry, a saving of valuable time, and subscribers would get better use of their instruments. In other words, it would pay the subscriber to learn how to use his telephone.

Of course it often happens that the line called for is already engaged. The switchboard automatically tells the operator whether this is so or not. Before pushing the plug into the spring jack, she taps it lightly on the outer rim. If the line is already in use, a distinct click in her head telephone warns the operator to proceed no further. The click informs her that the line is connected with some other, and no operator would be so illbred as to break in on a conversation already under way. Consequently, she informs the first subscriber that the number he has asked for is busy, often obligingly adding that she will call him when the line is free. If, when she gives the preliminary tap on the spring jack, there is no click, she knows that the line is not in use, and completes the connection without more ado.

When a subscriber is finished talking he should ring off. From the habitual neglect to do so, the operator is obliged to keep a watch on him, and if, while he is still talking, she asks if he is "through," he gets angry, or savagely asks to be let alone. She may have connected a dozen other subscribers in the meantime, and would be pardoned for the soft intrusion, if he knew as much about the working of the instrument as he should. If, on the other hand, she neglected this precaution, his line would often be incorrectly reported busy and his office cut off from communication unnecessarily. This may mean lost business to the subscriber, and loss of time to his customers.

Another thing that the subscriber does not understand is the fact that it is more trouble for the operator to report a desired subscriber "busy" than to make the connection. He often thinks that she is too lazy to ring them up, or that pandemonium reigns in the central office, and she cannot hear anything because of the deafening jingling of bells.

The "noise" in the office amounts to a gentle, continuous murmur. It is not even a buzz or a hum of voices. There is a medley of words, but pitched in such low tones as to be incomprehensible. Ten feet away from an operator you could not distinguish what she is saying.

Every girl at the switchboard wears a head telephone which keeps the receiver always at her ear. It is made as light as possible, and is secured to her head by a double band of plated metal ribbon, for all the world like a Greek fillet. This leaves her two hands free and enables her to do quicker, if not double work. At first the girls objected to the use of the head telephone. Some declared it gave them a headache, others thought it too heavy, a third class found it necessary to dress their hair lower, and the great majority were averse to wearing it for a woman's reason—because. The instrument was improved in various ways. Cords which might hurt the softest heads were replaced by flat braid, and later by the thin fillet of metal, and the ear piece was shorn of every atom of superfluous material.

No more questions were asked. The operators were simply told to wear the head telephones, which they did at once with the sweetest grace imaginable, proving that lovely woman likes to feel the hand of steel under the velvet glove. These head telephones are so free from physical objections, and so conducive to speedy and perfect service, that numerous requests for them are received from subscribers; but so far subscribers have had to content themselves with the ordinary hand telephones.

In the course of my tour of inspection through the exchange, in which I was accompanied by the chief electrician of the company, I learned many strange and wonderful features of the telephone business. The great office where I was initiated in the mysteries of the telephone, imposing as it is in its vast display of ingenious apparatus and human skill, by no means provides for all the subscribers in New York. Scattered about the city there are five other important exchanges, and two more are in course of equipment. It is so in all large cities. Exchanges are placed in various districts and all the exchanges are connected together by special systems of trunk wires to facilitate rapid communication between distant subscribers.

Although the telephone girl is, to the general public, the prominent individual in the company, and although she figuratively holds the topmost position, as she always occupies the upper story of the building, a vast force of workers and an immense amount of machinery and wires interpose themselves between the switchboard over which she presides and the subscriber's instrument. In modern industries, even in electrical and mechanical industries, there is nothing more complex, nothing which needs more careful and constant supervision, than a great system of telephonic communication. The telephone itself is one of the most delicate appliances placed in the hands of the public, and few people know how to use it properly. An army of inspectors make daily rounds among the subscribers, replenishing the batteries, adjusting the transmitters, bells, and receivers, and giving a deft touch here and there to maintain harmony between the different parts. Experts of long training overlook the work of these inspectors, and give subscribers useful hints to enable them to get the best results from their telephones.

The lines receive equally careful attention. The greater part of the telephone lines in big cities are now underground. In New York there are over 30,000 miles of underground wire for telephone lines alone, divided up into between 9,000 and 10,000 circuits. Every one of these circuits must be perfect from the subscriber's instrument to the switchboard. It has to pass through numerous connections, it has to be provided with its lightning arrester to prevent damage to instruments and it has to be free from and independent of all other circuits at every point.

At each exchange there are distinct forces of men to look after all this work, and more besides. There are engineers and electricians to superintend the building and repairing of lines, the laying down and testing of cables, and the complicated equipment of exchanges. There are chief inspectors, who test the subscribers' lines every day, and send out "trouble men" to make necessary repairs. There are wire men who set up instruments and trace out the maze of wires running through the exchange from the ends of the cable to the switchboard. There are men for everything, and a responsible chief for every branch of the work. If any one wishes to study organization carried out to a fine point, let him follow up the methods and system of a large telephone company.

It is sometimes said that the telephone service is not properly looked after. Nobody could say that after making such an inspection of the system as I was enabled to make. A single point I learned will show that the telephone subscribers' interests are guarded in the most thorough manner. The company's staff provides for every nine subscribers one active worker; thus every telephone subscriber may know that one man in the telephone company does an hour's work for him in some way or other every day.—*Electricity.*

ON THE CONSTRUCTION OF A BATTERY OF MINIATURE ACCUMULATORS.*

By C. L. WEBER.

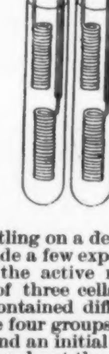
To charge electrometer needles, and for similar laboratory work, a Zamboni dry pile, or a battery of voltaic cells, is usually employed. Such appliances, useful for static effects, are useless when a current is taken out of them. If miniature Planté accumulators are used, their capacity is but small. For the calibration of torsion galvanometers, voltmeters, etc., and for measuring the insulation resistance of cables or electric light circuits, a battery is often required which shall retain a constant E. M. F. of 100 volts, with an external resistance of 10,000 ohms; in other words, a battery is wanted which shall be able to yield a current of about 10 milliamperes. The author has recently constructed, for the Munich testing laboratory, a battery capable of furnishing such a current for 36 hours.

The cells are made up in stout glass test tubes, 11 cms. high and 1·6 cm. in diameter. The spiral electrodes are formed of lead wire 1·5 mm. in diameter and 50 cms. long. These spirals are arranged as shown in the figure, and are filled with active material. The leading-in wire of the lower electrode is protected by a piece of glass tubing. A paste composed of minium and sulphuric acid is put into the lower spiral, the upper one containing a litharge-sulphuric acid paste. The paste should be left to dry for about 24 hours before pouring in the electrolyte. The 60 cells of the battery were mounted in groups of 10 between two glass rods, supported at the ends by wooden uprights, the tubes being kept vertical and separate by India rubber bands. The whole battery can be inclosed in a box 29×16×18 cms.

This 60 cell battery is charged from the electric light mains in three parts, a liquid resistance of between 1,000 and 5,000 ohms being interposed in the circuit, so that at the commencement the current is only 20 milliamperes; it is, however, gradually run up to 100 milliamperes, which is equivalent to about 30 milliamperes per group.

After having been formed and duly charged, the battery, having been carried about and made considerable use of, was discharged for 36 hours through a resistance of 10,000 ohms. At the commencement of the test the terminal E. M. F. was 120 volts and at the end of the test 100 volts.

The battery can easily furnish more powerful currents. Thus, in the above test the discharge current was at first 48 milliamperes, though at the end of seven hours it had fallen to 35 milliamperes. It has even been discharged at the rate of 65 milliamperes. The normal charge is 30 to 40 milliamperes for 20 hours. The loss of charge is small. At the end of a charge the E. M. F. was found to be 120 volts, and at the end of a week it was still 110 volts. This battery possesses a high capacity for its size, and may, therefore, prove of use for testing purposes.



Before finally settling on a definite mode of construction the author made a few experiments with regard to the disposition of the active material. He made up four groups, each of three cells; the lead spirals were all identical, but contained different quantities of active material. The four groups were all submitted to the same *regime*, and an initial current of 10 amperes being taken out of each set the time which this current took to fall 7 per cent. was noted:

	I. No active material.	II. + Electrode empty, —Electrode litharge	III. Both electrodes litharge.	IV. + Electrode minium. Electrode litharge.
Terminal volts......	8·8	7·0	6·4	6·3
Duration of discharge, in minutes..........	2	19	39	67

—*The Electrician.*

* Abstract from *La Lumiere Electrique.*

IMPROVED PROCESS OF MANUFACTURING STEEL.

HENRY CLEMENT SWINNERTON DYER, of Westhope, England, has invented improvements in manufacturing steel, of which the following is a specification: When using an open hearth furnace when working with the basic process, I commence by increasing the carbonization of the metal in the bath to any required degree. I charge, in the first instance, a suitable quantity of carbonaceous material, such as coal, coke, graphite, charcoal, or other similar substance, but preferably charcoal, on account of its freedom from impurities, and then charge scrap or pig iron and scrap on top of it. As the metal melts it takes up a considerable percentage of carbon, and although in the basic process much of the carbon is eliminated with the phosphorus, enough remains to enable the charge to be finished by boiling down with ore in a similar manner to the boiling down of an ordinary charge of pig in a silicious lined furnace. In this way a steel can be produced having any desired percentage of carbon within certain limits. Hitherto one of the greatest defects of the basic process has been that considerable difficulty and uncertainty is experienced in making steel with more than about fifteen per cent. carbon.

By my process I first saturate the bath itself with carbon, so that when the phosphorus has been eliminated there will still remain a percentage of carbon in excess of what is required at the finish, and afterward I remove this excess in the ordinary manner by boiling down with ore, so that when the furnace is tapped the metal shall contain exactly the percentage of carbon desired.

It has generally been believed that phosphorus will not leave the metal in the presence of carbon. I find in practice that this idea is erroneous, and that, al-

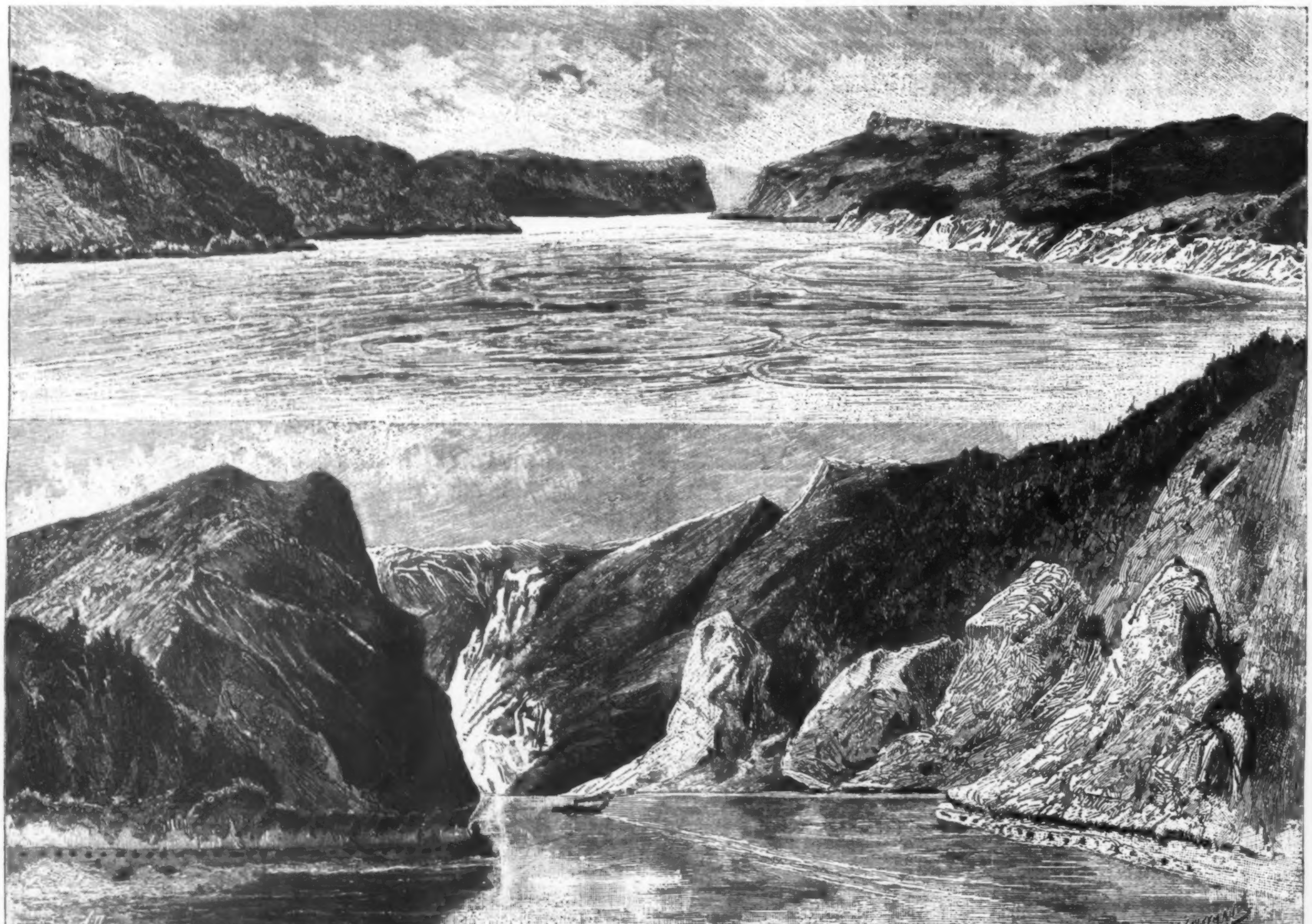
though a large proportion of carbon is eliminated with the phosphorus, still that, when there is an excess of carbon, sufficient remains to obtain steel with much higher percentage of carbon than has hitherto been found to be practicable with the basic process.

PROGRESS OF THE ENGINEERING WORKS ON THE DANUBE.

THE Danube, the largest river of Europe after the Volga, since it has a length of nearly 1,800 miles from its source in the Black Forest to its mouth on the Black Sea, is navigable starting from Ulm. Although the navigation of it is easy in the greater part of its course, where in places it forms true lakes of considerable width, it is interrupted, at least in part, by great rapids between Drenkowa (Hungary) and Scola-Bladowa (Servia). As may be seen from our engravings, these rapids are produced by the meeting of banks of rocks, through which the furious water flows and produces immense eddies. Flat-bottomed boats are nevertheless able to pass at certain places, but boats of a greater draught than five feet either have to transship their cargo or else await the season of freshets; and at this moment, if the draught of water is sufficient, to how many dangers is not one exposed amid the innumerable reefs then hidden by the sheet of water! The last and largest of these rapids, situated near Orsava, in Transylvania, has received the name of the Iron Gates, because the Turks, when they owned the two banks of the river, completely intercepted this dangerous pass by means of an iron chain extending from one bank to the other. Attempts have been made from very remote times to free the river from the obstacles that prevent traffic from being given all the importance that it ought to have, and near the Iron Gates there may still be seen traces of the work done by the Romans. In 1874, an international commission was appointed to ascertain the most efficacious means to be employed. This commission, composed of competent men, estimated the expense at $2,800,000. At that time the matter was not followed up; but the Austro-Hungarian government, desirous of opening up the country to international navigation, not long ago took up the question, and, although the new estimate carried the probable expense up to $4,000,000, the work was begun. It extends for sixty miles between Alt-Moldava and Turn-Severin. The object of the work is to excavate in the river a channel that shall have a minimum depth of six feet beneath the lowest water for a constant width of twenty feet.

There are no important excavations to be made in the bed of the river except at the Stenka, Kozla, Tachtalia, Greben, and Inez cataracts. At the Iron Gates, the river bed is left for an instant and the channel is excavated in dry earth upon the right bank. The work as a whole includes no less than 14,120,000 cubic feet of very hard rock to be blasted and 35,000,000 cubic feet of dikes to be constructed, without counting the rock work. This work, rendered difficult by reason of the violence and irregularity of the current, is in charge of Mr. Hadju, a Hungarian. The removal of the rock under such conditions necessitates, as may well be imagined, special machines. It is to American, French and English engineers that are due the three types adopted. The Lobnitz machine breaks the rock through the impact of a powerful stamp. The Tedesco diamond drill boat and the Ingersoll percussion drills permit of forming holes in the hardest rocks in order that the latter may afterward be blasted.

Up to the present, nearly a quarter of the sum anticipated has been expended, and it will be about three years before the work is entirely finished.—*L'Illustration.*



THE ENGINEERING WORKS AT THE MOUTH OF THE DANUBE—1. THE RAPIDS OF KASAN. 2. THE GREAT GATES.

LOCOMOTIVE BOILERS.*

By F. W. DEAN.

I BELIEVE it is estimated that there are about 150,000 locomotives in existence, and with few exceptions they have the usual form of staybolt boiler. The inference might therefore be drawn that this is the safest type of boiler in existence, as an explosion is comparatively unknown. There is, of course, an occasional explosion, but this should not be placed to the discredit of the boiler.

Let us glance at the service which the boiler performs, and in order to appreciate it, a comparison of its duty with that of stationary boilers is interesting. A stationary boiler when working at an economical rate evaporates some two or three pounds of water per square foot of heating surface per hour, but the locomotive evaporates seven to fifteen, more commonly ten to twelve. The stationary boiler is allowed eight to fifteen feet of heating service per horse power, but the locomotive boiler has but one to four. The temperature of the escaping gases of stationary boilers is not much over 400 degrees, while those of locomotives have ranged from 600 to 1,200, very commonly 800. If the pressure is 150 pounds per square inch, a pound of steam occupies a volume of 2·75 cubic ft., and 15 pounds occupies 43·75 cubic ft. Such a rapid formation of steam calls for a full opportunity to escape and points to the undesirability of overhanging furnace side sheets. The heat from the fire is transmitted into the water by the staybolts, and the larger the heads, the more efficiently this is done.

The severe service to which the locomotive boiler is subjected is more apparent when we consider the amount of coal burnt per square foot of grate per hour. In stationary boilers it is from five to 20 pounds, in locomotive boilers from 60 to over 200. With these consumptions the evaporation per pound of coal is low, with good coal five to seven pounds of water. The boiler is subjected to great and sudden extremes of temperature, for if it steams too freely the door is opened wide. Recent tests of the quality of steam show that even when working hard the boilers of locomotives send over less than one-half of one per cent. of moisture less than is found in many stationary boilers. This is due to large water service and steam space. No locomotive boiler was ever too large, or is likely to be, for the reason that from the point of view of economical use of fuel the boiler is always overworked.

The first matter to decide upon with reference to a boiler is the quality of the material. It is easy to obtain good steel from the various makers throughout the country, and it is probable that any maker can deliver good firebox steel if required.

The most valuable quality which boiler plates can possess, provided that it is not at the sacrifice of any other, is a high elastic limit. By elastic limit is meant the greatest stress per square inch to which it can be subjected without injuring its elasticity. If the steel is strained within this limit, it returns to its original length after the load is removed. If the stress goes beyond this limit the steel breaks down, so to speak, is out of shape, and the boiler becomes leaky. A boiler should have its factor of safety determined with reference to the elastic limit and not with reference to the ultimate strength of the plate. This shows how unnecessary and unwise it is to specify the ultimate strength, except the upper limit, in order to prevent an excess of carbon. In other words, if the elastic limit is brought about by working a low carbon ingot and is accompanied by great elongation and contraction of area upon being tested, it should be the most important quality of steel. It is well known that it is easy to secure a high elastic limit in thin plates on account of the amount of work which is put upon the ingot by the rolls. This points to the importance of having thick ingots for thick plates, and an ingot some twenty-five times as thick as the plate to be rolled gives good results.

Besides tests for elastic limit, elongation and contraction of area, it is well to have quenching and bending tests. This is done by heating a piece of plate to a cherry red, plunging it in water and then bending it over a cylinder whose diameter is twice the thickness of the plate. Most steel will, however, bend down flat under a hammer after quenching, without fracture.

For fire plates it is best to be content with a low elastic limit, say 30,000 to 32,000 pounds to the square inch, and to secure strength by thickness of plates and frequency of stay bolts. Test pieces should be long enough to give the elongation in no less than eight inches in order to enable us to judge better of the material, for if the length is restricted we compel the elongation to take place in too small an area to be representative. Every effort should be made to prevent any part of boiler plates being strained up to the elastic limit. Plates can be so strained by punching and flanging. If holes are punched ⅛ in. small and reamed to size, the injured material is mostly removed, but the proper way is to drill all holes in place. When a boiler shop is once fitted for this work the expense is but little greater than for punched work. If reaming

* Read at a recent meeting of the New England Railroad Club, Boston, Mass.

is done it would be better to drill the holes of an inner plate with the outer punched hole as a guide. This assures fairness of holes and avoids eccentric reaming. If both holes are punched the reamer will become inclined and cause eccentric reaming in both holes and remove only a part of the injured material from each.

A plate-closing ram of a riveting machine, unless used with care, overcomes the elastic limit by making a circular indentation around the rivet hole. Considering that this is the weakest part of the boiler, viz., the joint, it should be particularly avoided. The elastic limit is often overcome by flanging and this indicates the importance of annealing plates after flanging. This would probably delay the almost inevitable cracking that takes place in the throat sheets of boilers when they are spread out to join the circular part of the shell. The inner sheets without doubt become annealed in service, so that if they do not crack when new, they are not likely to do so.

The general direction of the circulation in locomotive boilers is upward at the firebox and forward in the upper part of the boiler, downward at the forward end and backward at the bottom. It is obvious that the more freely this natural movement takes place, the more freely the steam escapes. The escape is undoubtedly facilitated by the jar of the engine, and this is an advantage which the locomotive boiler possesses over stationary boilers of any kind. Now let us see what obstructs circulation. It would be obstructed by an insufficient feeding of the water spaces, and for this reason I advocate a very wide front water space in order to properly feed the side spaces. I advocate side sheets which do not follow the form of the outside sheet, but which are slightly inclined inward, provided no disadvantage follows. When the firebox is between the frames, as is generally the case in New England, this makes a narrow firebox at the top, but it can accommodate a wide tube sheet by being flanged out forward. This has been the practice on the London, Brighton & South Coast Railway for many years.

Circulation can be facilitated by abandoning transverse crown bars, as they obviously interfere with the upper horizontal current of water. The general circulation in the barrel can be facilitated also by using a large shell and placing the tubes far apart, and by placing the tubes farther apart horizontally at the front end than at the other. The inclination of the tubes to the tube sheets is so slight that the tubes are as tight as usual. The writer has practiced this method for several years in stationary boilers. Inclining the side sheets of the firebox not only promotes better circulation but gives greater elasticity to the upper stay bolts by making them longer, and this prolongs their life. The usual method of accomplishing this desirable end is to use enough stay bolts at the top to make the structure in that vicinity sufficiently strong and rigid to throw relative movement between the plates elsewhere. The long stay bolts would render this unnecessary, or if more strength of stays is necessary at that point, a larger diameter of bolt can be used. Another advantage of the narrow crown sheet is that fewer crown stays are needed; shorter bars can be used if they are transverse, and fewer if they are longitudinal. The longitudinal bars, besides interfering with the horizontal circulation less than the others, permit the longitudinal tie rods to be placed where they are needed for properly staying the back head. I have seen some boilers that have these rods dangerously far apart. In order to properly support the longitudinal bars, the outer crown sheet should be stiffened with two heavy T irons from which the bars can be supported at two points in each, as in English practice.

Next let us examine the form of the boiler about the fire box. The circular form of a flexible thin shell is the form which it takes when subjected to uniform internal radial pressure, and therefore if it is circular it is in equilibrium and will maintain its circular form when subjected to such pressure, and not otherwise. Let us examine what occurs with a crown boiler under pressure. There are in many cases as much as 200 tons of pressure tending to force the inner fire box downward out of the boiler. How is this pressure resisted? It is resisted by the base or mud ring at the bottom, which tends to rotate (and this points to the advisability of double riveting this ring), by the stiffness of the stay bolts, and by connections from the crown bars to the shell above. The crown sheet, of course, tends to go down, and actually does so, as I have found out by experiment. In doing this it bulges out the curved sides of the inner fire box. In depressing, the crown sheet seeks assistance from the outside crown, but this being in equilibrium from internal pressure, and thin, is as unable to resist distraction from this cause as a distended toy balloon is unable to resist the pressure of the finger. It therefore depresses and the sides bulge out. The inner crown sheet surely goes down, the sling stays are in unequal and absolutely unknown stresses, the upper and other stay bolts are bent, and all conditions for over-straining and breakage are present.

Transverse tie rods just above the crown sheet simply modify the unknown stresses, but do not simplify the chaotic condition of them. This is enough to cause stay bolts to break, and in my opinion is the great cause, rather than the expansion of the side sheets. The depression of the outer shell forcing out the sides assists in cracking the upper part of the throat sheet. Another common feature of construction assists in this last phenomenon. I refer to the common practice of not using a circular form to the outer crown sheet, not that this would do any good to this sheet, but it would give circular cross sections to the conical part of the shell immediately in front, thus avoiding a flat place on each side. This flat place tends to bulge out, and assists in cracking the throat sheet.

The radial stay system has the same faults as far as stresses in the parts are concerned. When the boiler is under pressure the stays are in unequal and unknown stresses, and many parts must be dangerously strained. The Wootten variety of this form is an extreme case, and its weakness is more apparent. If we take a cross section of this we shall see that the pressure acts upon the sides as it does upon a Bourdon tube in a steam gauge, and it tends to straighten out as the tube does. It is easy to see that the tendency is to pull the stay bolts out of the thinner sheet. This shows the necessity of tying the sides of the mud rings to each other at intervals. My own opinion of all the forms of boiler thus far described is that they are unsafe. Any structure in which the stresses cannot be computed is likely to be unsafe.

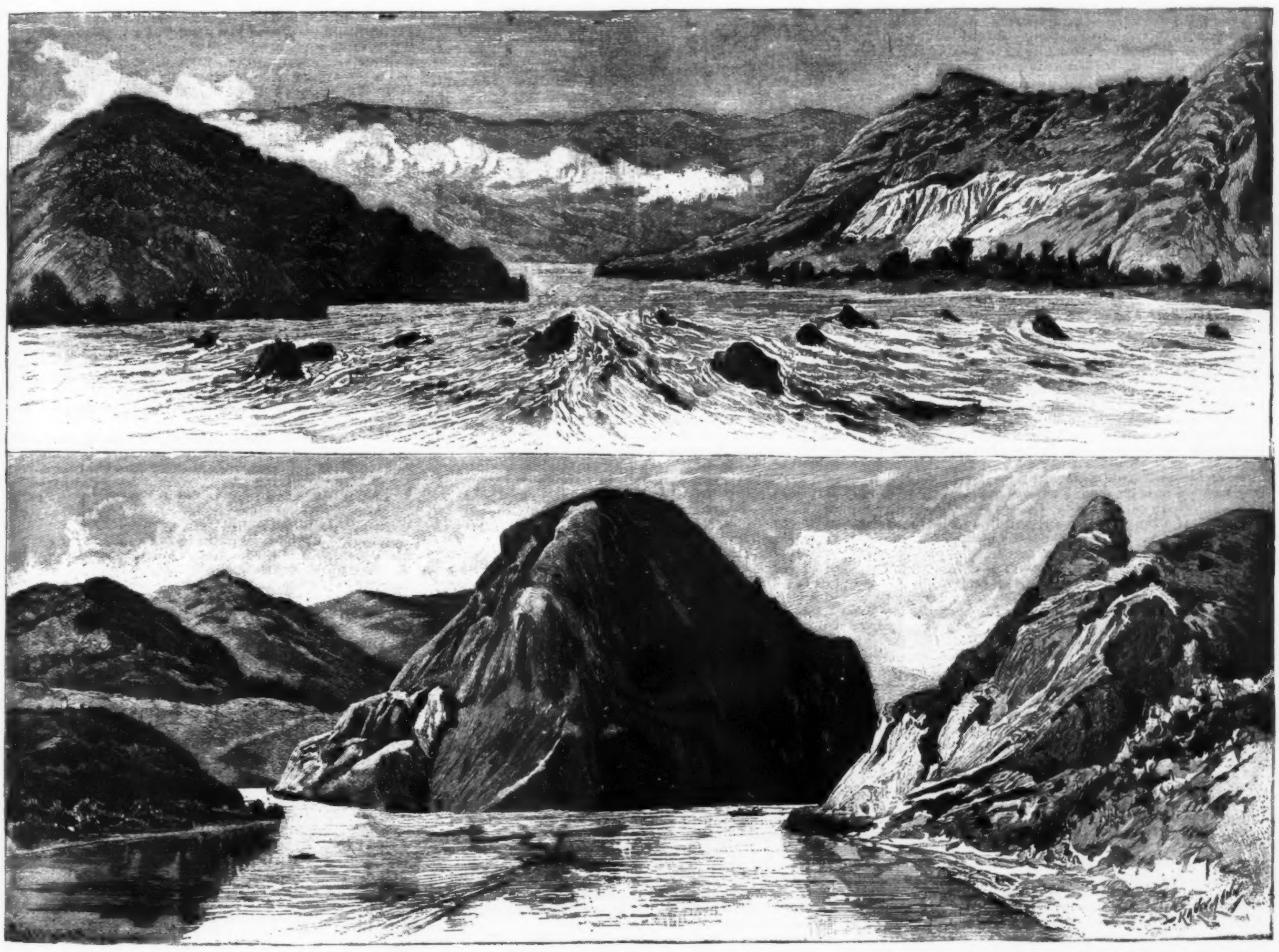
Now let us see if there is not some form of boiler which is free from all these defects, in fact, a boiler which possesses nothing but virtues. If we had a boiler which tends to lift up the crown sheet as much as that sheet tends to go down, it is evident that there would be no pressure tending to force out the fire box, to rotate the base ring, to bend the stay bolts, to render computation useless, and to distort the outer shell. The Belpaire fire box, named after its distinguished inventor, has these qualities, and the principle of its design is this, that any flat surface of the inner fire box has a companion equal flat surface upon the outer. This permits the corresponding surfaces to be stayed together by stay bolts of various lengths, and all pressures are perfectly balanced. Moreover, as the stayed plates are flat, they are elastic and yield to movements produced by changes in temperature. Every part can be properly stayed, the stresses properly computed, and the conditions of stress are not changed when the boiler is hot.

This boiler is safe with any pressure for which it is designed. As the crown sheet does not go down, stay bolts will break less than in any other boiler. Circulation is free over the crown sheet, water surface and steam space is great, and longitudinal tie rods can be placed where needed. The weight is a minimum because every part is proportioned for its stress.

With this boiler carefully worked out, I should not anticipate any cracking of the extremities of the throat sheet.

Of course boilers of this kind can be imperfectly worked out, and trouble will follow, but what I mean to say is that if this boiler is properly designed, most boiler troubles will disappear. Flat places should be carefully sought out, and there should be no staying between the back head and this outer crown sheet.

Of course there is no difference of opinion as to the superiority of the butt joint for boilers with inside and outside covering plates. The circular form is preserved best by it, and it gives the strongest joint. In case an extra strong joint is wanted—and who does not desire it?—the inside plate can be extended beyond the outside, and one or more rows of wide-pitched rivets placed through it and the shell proper. In this case



THE ENGINEERING WORKS AT THE MOUTH OF THE DANUBE—THE IRON GATES—1. THE RAPIDS OF DOBRA. 2. THE WHIRLPOOL OF KASAN.

the inside plate should be as narrow as is consistent with the object in view, because any inside plate tends to straighten out between the rows of rivets, and thus be ineffective in a measure. This plate should be as thick as the shell, in order to minimize such a tendency, but it should be pointed out that this tendency would not exist if the inside plate should be calked, and thus the steam prevented from getting between it and the shell. The calking cannot be done, however, unless the covering plate is very thick and scalloped around the rivets. Whenever a joint is made in this way, and it is not uncommon in foreign marine works, the narrow plate is placed inside and the wide scalloped plate outside. This makes the strongest possible joint and probably has an efficiency of nearly 95 per cent. of the boiler.

While upon this point I wish to point out the deceptive nature of a joint that is frequently seen on locomotive boilers. I refer to the lap joint with an inside bent covering plate. I have watched the behavior of large sections of this joint in the Watertown testing machine, and can testify to the all but uselessness of the welt. Its action is to straighten out and allow the main part of the joint to be ruined before it is pulled taut, at which time, of course, its own elastic limit is passed at the bend. Such a welt should always be thick and the rivets nearest the bend should be as close as possible to it.

Concerning tubes, many people believe that long tubes are objectionable. It should only be remembered that the smoke box temperatures of our locomotives are between 600 degrees and 1,200 degrees, while the temperature of the steam is not usually much above 300 degrees. We either want longer tubes or more tubes of the present length. In other words, in the usual type of bituminous coal burning locomotives the heating surface should be more than 73 times the grate surface, which is the common ratio. In France this matter of tube lengths has received much attention, and tubes 16 feet long have been used for years.

In conclusion I wish to call attention to the device of a Frenchman for increasing the heat-absorbing surface of tubes—the Serve tube, which has longitudinal internal ribs, thus increasing the inside surface some 90 per cent. These ribs not only possess more surface, but the ribs slice up the gases and abstract the heat from the center. It seems to me that this provides a most promising means of cooling down the gases in locomotive boilers. Tests have shown an increase of evaporation per pound of coal of some 10 per cent. to 15 per cent.

Mr. LAUDER: I have heard these matters discussed for the last thirty or thirty-five years by scientific men, practical men, constructors of boilers and users of boilers, and have heard the poor old locomotive boiler sadly abused, yet for sixty years it has done its work, and done it well. I have never been able to discover the weaknesses in the old locomotive boiler that Mr. Dean mentions. He says that the boiler we are using is a dangerous thing, and yet while there are tens of thousands of locomotives in use all over the country, using all kinds of water and fuel, run by all kinds of men, some with good care and some with poor, there is scarcely a case on record where a locomotive boiler has exploded; occasionally there is one, generally an old one. If a boiler is properly built and tested, properly inspected and taken care of, and the repairs looked after when weaknesses are discovered, there is little danger of explosion. I have never discovered any particular merit in the radial stay boiler. With the good water we have in New England, I see nothing wrong with the ordinary type of boiler, with the fire box stayed with crown bars; it has stood the test of service for a good many years. Where the water is bad, impregnated with alkalies, the crown sheets are soon used up, and the radial stay boiler is better for use; but under the circumstances, I should prefer to use the Belpaire boiler. That boiler practically is right, but it has developed some weaknesses, possibly due to not being properly designed. Whether it can be designed to stand the rough usage which most locomotives get, I think is an open question. It has the merit of having flat surfaces both of the inside box and the outside shell. The theory that when a boiler is under high pressure the outside circular crown is flattened by the pull-down of the sling stays I think is largely imaginary; if that occurred to the extent sometimes supposed, the plates forming the outer crown would soon give way. It is true that that has sometimes happened. We have had longitudinal cracks develop in the outside crown of locomotive boilers, but it was always where that outside crown was made in three sheets, with a double riveted lap seam, which invites this trouble. With regard to the supposed want of circulation in the locomotive boiler, I think the circulation of water in a well designed modern locomotive boiler is almost perfect. Were it not so, with the intense heat generated in the furnace, the plates would soon show the effects of over-heating.

Mr. DEAN: Mr. Speirs has shown by direct experiment that the crown sheet does go down on the side; he found it went down over 0·06 of an inch, and it is not unreasonable to suppose that the middle went down further. I remember a 90-inch boiler with a nine-sixteenths inch plate, and the outer crown sheet was stiffened up very much by heavy bars riveted to it. I put a templet on that boiler, making it go over between two certain points, and found the middle of the outer crown sheet fell 3-32 of an inch.—*Nat. Car and Locomotive Builder.*

WORLD'S CONGRESS OF ENGINEERS.

AMONG the various congresses which are being promoted by the "World's Congress Auxiliary," it is proposed to hold in Chicago, during the Columbian Exposition of 1893, an International Congress of Engineers. Its organization has been made a separate department of the "Auxiliary," and has been intrusted to the undersigned committee, assisted by an Advisory Council, which will constitute the non-resident branch of the Committee, and will co-operate with it by means of correspondence.

Moreover, the various engineering organizations of the United States and Canada have formed a voluntary association, for the purpose of providing headquarters for engineers who may visit the Exposition, and of promoting the Engineering Congress. The information already received by this association makes it evident that there will be a large attendance of both foreign and American engineers.

The principal objects of the Congress will be to enable engineers to inform each other concerning the latest, best and most economical practice in methods of construction and operation, machines, processes, experiments and investigations, including standards of efficiency, tests and measurements, to compare and interchange ideas, and to discuss points of professional interest.

It is expected that the Engineering Congress will take place probably in the month of July or August, 1893, and will last six days, a portion of which may be devoted to visits for the inspection of objects of engineering interest. The "Auxiliary" is to furnish the halls and the rooms for the meetings, and to attend to the subsequent publications of the proceedings and papers, but this will not prevent the various societies holding sessions in the Divisions or Sections of the Department from publishing the papers and proceedings in their transactions.

The Congress is to begin with a joint meeting and appropriate addresses, and in view of the wide scope of engineering specialties, it is then to be divided into seven General Divisions, as follows:

General Division A—Civil Engineering.
" " B—Mechanical Engineering.
" " C—Mining Engineering.
" " D—Metallurgical Engineering.
" " E—Electrical Engineering.
" " F—Military Engineering.
" " G—Marine and Naval Engineering.

These divisions may be divided into as many chapters or sections as may be found desirable. The Congress may terminate with another joint session.

It is expected that each division will be organized in advance with the active aid and co-operation of the representatives of the National Society or Governmental department corresponding thereto. Such organization will include a chairman, vice-chairman, secretaries and advisory council of the division; and will select the subjects to be discussed, promote and receive voluntary papers, and arrange for discussions thereon, and generally prepare an approximate course of proceeding.

The work of every division will consist in:

First: The discussion of subjects chosen by the officers of the division.

Second: Reading of selected voluntary papers, and discussion thereon.

The officers of each division will be expected to cause analyses of the engineering subjects selected to be prepared by specialists in advance to serve as an introduction to the intended discussion: and also to endeavor to secure the attendance of engineers prepared to discuss them.

Voluntary papers to be solicited from engineers throughout the world, in either English, French or German, not to exceed fifteen minutes in presentation, and not previously published or communicated to any society, are to be sent in advance to the secretary of the division for which they are intended, and passed upon by its officers. Papers or abstracts will be printed and distributed if received in time, and the discussions will be under such rules as may be formulated by the undersigned General Committee of the World's Congress Auxiliary.

The Committee therefore bespeaks the co-operation of all engineers in making this Congress a success. It is only through their aid that its work can be made satisfactory.

The following tentative classification of subjects is submitted, and suggestions are invited in relation thereto, and in regard to all other matters connected with the Congress, to be used in the formation of the final plans.

GENERAL DIVISION A.—CIVIL ENGINEERING.

Subjects.

Railways.—Location, construction, equipment, operation, maintenance, and terminals.
Canals.—Construction and operation.
Water Works.—Dams, aqueducts, filtration, and distribution. Pumping and gravity systems. Reservoirs and aeration.
River Improvements.—Regulation and control.
Harbors.—Jetties, breakwaters, lighthouses and other signals, piers, docks, wharves, and dredging. Removal of obstructions to navigation.
Drainage.—Sewage and sanitation.
Roads.—Highways, streets, pavements, and curbing.
Reclamation of marshes, sand dunes.
Foundations.—Independent piers, piles, coffer dams, caissons, pneumatic and other methods.
Tunnels.—Subways, shafts, and deep wells. Ventilation of tunnels.
Strength and Employment of Materials.—Testing machines, tests.
Surveying.—Land, cities, public works, etc.
Street Railways.—Animal, cable, and electrical, etc.
Instruments of Precision.—Transits, levels, etc.
Masonry.—Viaducts, arches, aqueducts, bridges, walls, etc.
Bridges.—Truss, plate-girder, and suspension. Cantilevers and arched girders.
Construction of buildings and towers.
Handling and storage of grain, coal, ores, etc.
Elevated Railways.—Underground railways.
Irrigation.—Artesian wells, hydrography.
Constructional Appliances.—False works, cranes, etc.

GENERAL DIVISION B.—MECHANICAL ENGINEERING.

Subjects.

Motors.—Steam, air, explosive, hydraulic, and wind.
Machines.—Excavators, dredges, cranes. Planting, cultivating, and harvesting machinery. Animal, steam, and manual power machinery. Brewing and distilling apparatus. Wood-working machinery, pulp-making and wood-preserving apparatus, logging tools and machinery. Tanbark, turpentine, and charcoal manufacture. Hydraulic rams and presses, elevators. Fire apparatus, engines, ladders, standpipes, chemical engines, etc. Sawing, planing, moulding, and veneering machines. Stone-working machines. Ventilating and warming machinery, stoves, ranges, hot air and steam heaters. The phonograph.
Instruments of Precision.—Scales, meters, measures, etc.
Tools.—Lathes, planers, emery wheels, presses, drills, punches, saws, shears, wood-working tools, etc.
Rolling Stock.—Locomotives, traction engines, cars, power brakes.
Power Transmission.—Cables, shafting, belting, compressed air, steam, hot water, hydraulic pressure.
Heat Transmission.—Steam, hot air, and hot water.
Steam Generators.—Boilers and settings, furnaces and grates, mechanical stokers, stacks, forced draughts, fuels, smoke consumers.
Gas Making.—Coal gas, water gas, vapor gas machines. Distribution, consumption, and measurement.
Testing Machines.—Tests.
Refrigeration.—Ice making and cooling machines.
Cable Railways.—Pneumatic railways. Rack railways.
Pumps, filters, blowers, fans, and miscellaneous machinery connected with engineering work.
Sanitary engineering and appliances.
Petroleum.—Pipe lines. Distilling and refining.

GENERAL DIVISION C.—MINING ENGINEERING.

Subjects.

Extracting Ores.—Iron, coal, copper, zinc, lead, tin, nickel, etc.
Drift and Placer Mining.—Gold, silver, diamonds, and other precious metals and stones.
Boring.—Petroleum, natural gas, salt water, and prospecting.
Preparation of Ores.—Roasting, concentration, etc.
Extraction, separation, and refining of products.
Explosives.—Gunpowder, nitro-glycerine, and allied explosives. Location, loading, and firing of blasts.
Mine Working.—Timbering, ventilation, and safety appliances. Draining.
Ore-working Machinery.—Boring and cutting, crushing and pulverizing apparatus.
Assaying.—Methods employed and comparison of results.
Surveying.—Prospecting and mapping. Instruments of precision.
Geology.—Mineralogy.
Quarrying and Allied Industries.—Graphite, asphalt, asbestos, clay, building stones, limestone, marble, cement, gypsum, salt, borax, phosphate, slate, etc., quarries and mines.

GENERAL DIVISION D.—METALLURGICAL ENGINEERING.

Subjects.

Smelting.—Furnaces, stacks, stones, direct processes.
Iron.—Manufacture of various grades of cast and wrought iron. Fuel, waste products, economy, etc.
Puddling.—Furnaces, malleable iron processes. Mechanical puddlers.
Steel.—Bessemer, basic, and open hearth processes, etc.
Rolling Mills.—Plates, rails, beams and shapes of various kinds. Long pieces, rolling from fluid metal.
Steel.—Working and tempering of steel for tool and constructional uses.
Wire.—Manufacture, sizes, strength.
Forgings.—Methods of manufacture. Sizes.
Aluminum.—The pure metal and its qualities. Its alloys and their qualities. The manufacture.
Alloys.—Gun metal, type metal, bronzes, etc. Their manufacture and qualities.
Fuels and Fluxes.—Their nature, costs, and effects.
Reduction and Working of Other Metals.—Copper, zinc, lead, tin, nickel, etc.

GENERAL DIVISION E.—ELECTRICAL ENGINEERING.

Subjects.

Telegraphy.—Systems: Duplex, quadruplex, multiplex, etc. Rapid telegraphy. Cable telegraphy and instruments. Batteries and telegraph dynamos. Circuits. Induction and telegraphy.
Telephones.—Systems, transmitters, switch-boards. Automatic apparatus. Magneto bells. Long distance telephony. Induction and retardation.
Lamps.—Arc lamps and carbons, incandescent lamps and filaments. Manufacture and durability. Sockets.
Wires.—Overhead systems, underground systems, cables. Insulation.
Distribution.—High tension, direct; low tension, direct; alternating. Simple circuits, compound circuits. Series and parallel systems.
Batteries.—Primary and secondary.
Generating Machinery.—Dynamos, alternating and direct. High and low tensions. Armature and field windings. Methods of regulation. Commutators. Mechanical details.
Motors.—Direct and alternating current motors. Armature windings. Regulating devices. Commutators and mechanical details.
Appliances.—For measuring and controlling currents of electricity. Switches, rheostats, meters, safety appliances.
Transformers.—Methods of winding, loss in conversion, heating, designs.
Mining and Metallurgy.—Boring, drilling and firing, pumping. Reduction of ore.
Welding.—Welding, brazing, soldering, tempering and forging.
Transmission of Power.—Short distances, long distances.
Signals.—Bells, annunciators, automatic calls, individual calls, etc.
Railways.—Single and double wire systems, rail transmission systems, geared and gearless motors, generators. Trolley and underground systems. Storage battery systems.
Electro-plating.—Current, solutions, time, etc.
Heating.—Resistance devices. Thermostats.
Execution.—Apparatus for destruction of life.
Photography.—Electrical devices for same.

GENERAL DIVISION F.—MILITARY ENGINEERING.

Subjects.

Fortifications.—Breastworks, arsenals, magazines, pits, mines. Protection of rivers and harbors.
Ordnance.—Light and heavy guns, rifled bores, breech-loading. Small arms, magazine guns.

Projectiles.—Balls, bombs, shells, bullets.
Explosives.—Gunpowder, gun-cotton, high explosives, compressed air.
Transportation.—Roads, bridges, pontoons, transport boats, wagons and animals.
Accouterments.—Tents, ambulances, camp utensils and balloons.
Sanitation.—Water supply and drainage.
Artillery.—Light and heavy, and their accessories.
Signaling.—Methods and systems, range finders.
Surveys.—Topography, mapping.

GENERAL DIVISION G.—MARINE AND NAVAL ENGINEERING.

Subjects.

Sailing Vessels.—Ocean, lake, yachts, ice boats. Methods of rig and of handling sails.
Steamships, steamboats, tugboats, steam launches, etc.
Naval Motors.—Steam, hot air, electrical, gas, etc. Boilers, automatic stokers, engine regulators and kindred appliances.
Designs.—Hulls, interiors, rigs, etc.
War Ships.—Armored, monitors, gunboats, cruisers, etc.
Ordnance and Armor.—Offensive and defensive.
Torpedoes.—Torpedo boats, guns and nettings.
Submarine vessels.
Diving Apparatus.—Armor, bells.
Hydrographic Surveys.—Deep-sea soundings.
Vessels for Special Service.—Ocean and lake freight or passenger, fisheries, etc.
Apparatus, Accessory.—Capstans, windlasses, steering machinery, blocks and tackles, anchors and allied appliances.
Signals.—Lights, rockets, flags, systems, etc.
Life Saving Appliances.—Boats, rafts, life-line guns, kites, etc.
Instruments of Precision.—Sextants, chronometers, compasses, etc.

Inquiries and communications should be addressed to the chairman.

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PICOT'S FOLDING TENT.

THE tent has at all times been a species of pavilion of coarse cloth to be set up in an open champaign as a protection against the sun and the inclemencies of the weather. The ancient patriarchs lived under the tent, and it is still the sole habitation of nomad people.

The Greek and Roman armies carried tents in their train, which they put up whenever the need of a somewhat prolonged rest made itself felt. Our ancestors, the Gauls, employed a tent mounted upon a wagon (Fig. 1).

Tents were not used in the middle ages, because war was not made in winter. Under Louis XIV., the troops were again provided with them. During the wars of the Revolution and of the Empire, at Valmy as well as at Waterloo, the soldiers camped out in the open air. The Revolution was not rich enough to offer its soldiers movable coverts, and the Emperor kept his grenadiers so much on the move that they had no leisure to camp.

Since then, sentiments of humanity have made their way, in the army as elsewhere, and we no longer, in any case, find soldiers sleeping *à la belle étoile*. Even the decks of ships are protected by strong canvas firmly secured to the masts and cordage.

Despite this, it may be said that almost all of the

FIG. 1.—A TENT OF THE TIME OF THE GAULS.

systems of tents employed are defective. It is almost always the same primitive mode of fixation by a central pole that is relied upon, other poles being used to support the top and keep the tent open, and the canvas being stretched by means of stakes. The entire system is stable, or nearly so, when the elements are calm. But, let foul weather come, and let the wind strike the tent at right angles or diagonally, and it will tend to pull up the stakes, and if these have been driven into solid earth, the canvas will give way and tear to the right of the loop, for at this place the warp and woof of the fabric are pierced in order to allow of the passage of the loop. Whatever be the strength of the canvas, it will finally tear. This inconvenience is presented by square tents as well as by round ones, and both are encumbered by the central pole, which takes up the best of the space and prevents a rational disposal of it.

As for the other forms of tents, of which so many specimens were to be seen at the Esplanade des Invalides during the Universal Exposition, their construction prevents them from being torn away only because of their massive framework of a weight which deprives them of all mobility.

The ideal is to have light, strong, quickly mounted tents that can be fixed on any ground, and that do not owe their adherence to the earth to the sole fact of fixation by stakes. Mr. Picot has succeeded in this way simply by applying the famous principle of Archimedes' lever. Let us consider, in fact, an attaching foot, F (Fig. 2, No. 3). We find here a socket of stamped steel plate into which enters an inclined support whose lower part terminates in a point, H, which is fixed in the earth. A jointed lever, connected with the socket, and having a length variable according to the size of the tent, lies upon the ground. This is fixed to a stake provided with a hook, as shown in Nos. 1 and 2 of Fig.

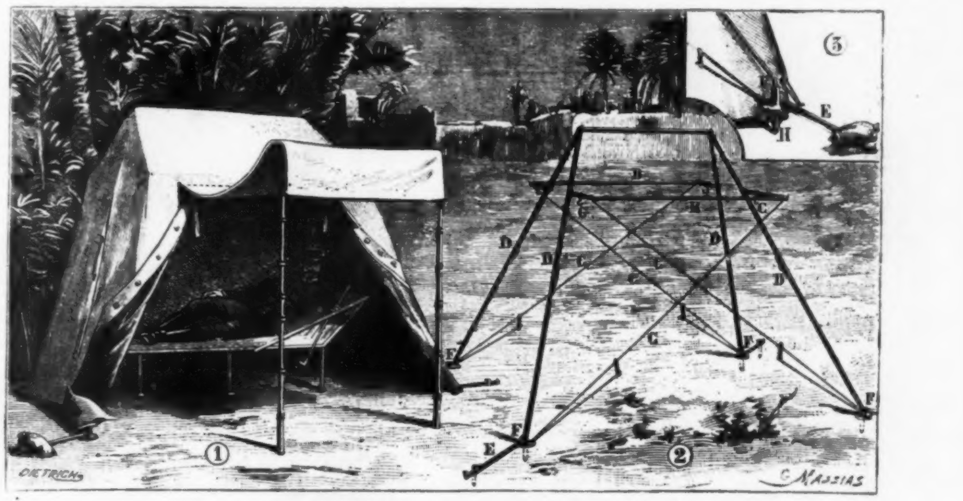

FIG. 2.—PICOT'S NEW FOLDING TENT.

1. General view. 2. A B, cross braces; C, tension ropes; D, jointed uprights; E, lever; F, eye to which the ropes C are attached; G, clothes hooks. 3. Mode of fixing the foot of the tent.

2, or else by some dead weight, such as a stone or bag of sand, serving as a counterpoise. We have thus an absolutely fixed point, which is so much the more fixed in proportion as the lever is longer and the weight heavier. With four uprights thus fixed and connected by the transverse bar, A (Fig. 2, No. 2), the framework of the tent may be said to be riveted to the earth. The tent is no longer held, as in all other models, by stakes to which the canvas is tied, but by its mounting properly so called, and this gives it great stability. The framework, the canvas and the fixed hook form an indissoluble whole, and in order to secure rigidity of the summit, there are hooked thereto tension ropes in the form of St. Andrew's crosses, attached on the one hand to the bars, BB, and on the other to the fixed points, F. So that if the wind attacks one of the faces of the tent, the parallels, BB, receive the thrust, and the entire stress is exerted upon the points, D and F, where the canvas is attached and cannot give way, be detached or be ripped. The uprights and cross bars are of hollow steel, and the latter are jointed in order to permit of being folded up. The weight of the mountings is 7·5 kilogrammes for a 2·3 × 1·5 meter tent like that shown in Fig. 2. The weight of the canvas, which varies according to the latter's nature, is from 8 to 10 kilogrammes, and may be as light as 6 if it is of ramie. It is impossible to imagine anything lighter and stronger.

Fig. 2 (No. 1) represents a tent for an officer, like those carried by Commandant of Engineers Marmier and the staff officers who accompanied him to the Soudan. It has three openings, one of which is capable of forming a veranda by the aid of two rods or two guns resting upon the ground (Fig. 2, No. 1).

For equatorial countries, it is indispensable to line the canvas with green satinet in order to diminish the ardor of the sun's rays and the coolness of the nights. This tent likewise renders the greatest services at the seaside. It can be easily moved about by two men. The bed which figures under the tent, in the form of a lounge, the unfolding of which there is no central pole or other obstacle to interfere with, has been devised especially for long voyages. It is easily folded up and may be reduced to a bulk of seven cubic decimeters. Its weight varies from 6 to 8 kilogrammes, according as it is of hollow or solid steel.

An impermeable canvas bag permits of packing up together the tent or the bed, which weigh in all about 22 kilogrammes.—*La Nature.*

THE CARE OF THE PATENT OFFICE.

AN INTERESTING LETTER FROM DR. R. H. THURSTON, DIRECTOR OF SIBLEY COLLEGE OF ENGINEERING.

To the Editor of the Scientific American:

SIR: The secretary of the American Association of Inventors and Manufacturers of the United States, announcing the annual meeting of that body, as set down for the 19th January, takes occasion to send to members copies of a circular letter, long since prepared, calling attention to the present condition of the Patent Office.

The facts have more than once been referred to in your journal; but it will be necessary to add, "line upon line, and precept upon precept," to secure tardy justice to the inventor and decent accommodations and healthful offices for his friends in the Patent Office. This injustice has been now persistent for a half century, and the appeals of generations of commissioners, of thousands of inventors, of the whole technical press, have, as yet, had not the slightest effect in bringing about a remedy. It is an instance of long-continued injustice and persistent barbarism not second to that illustrated, until recently, by the neglect of our national law-givers to provide decent accommodations for the National Library—for that institution which should have always been the noblest monument to the intelligence and enlightenment of the nation, but which was actually made for many years a most shameful reminder of the indifference and incompetence of a body which should have been composed of the most intelligent citizens, and the most thorough statesmen, that the country could boast.

The case of the Patent Office is vastly worse than even that, in some respects. The country owes to its inventors probably the major part of all its wonderful prosperity, its wealth, its greatest future. The nation, in the pursuit of a wise public policy, not at all with reference to the interests of the inventors themselves, except as the interests of the people dictate the encouragement and protection of the inventors and of their inventions, has provided a system of patent law which has secured the development of such enormously important and numerous inventions as have placed these United States in advance of the world; and a system which foreign nations are now tardily copying, with immediate and obvious advantage. An essential feature of this system is the Patent Office organization, by means of which—as I think most fortunately—every invention for which it is asked that a patent be issued must first be carefully examined to determine its probable novelty and usefulness. This gives the inventor some assurance that the document given has a real value, and that his invention is likely to prove real property. This is a great advantage to the inventor, as enabling him to negotiate the sale or the construction and introduction of his device, and to the people as giving a basis for business operations that may result in the prompt introduction and use of a device of value to the country.

This has been illustrated in the cases of the various modern steam engines, the most admirable features of railway operation, the telegraph, the telephone, the sewing machine, the myriads of electrical apparatus now coming in a flood to advance the material interests of the world. Under this stimulus, the world has advanced more rapidly than ever before, and makes greater progress in a decade than formerly in centuries.

But this service is not gratuitous, as it well might be, and yet the nation profits enormously by the operation; but the inventor, usually impecunious and without wealthy or influential friends, must pay to the government, not only the full cost of such examinations and of the issue of his letters patent, but a large profit as well. The result has been that the inventor has not only given the country its wonderful prosperity in large degree, its enormous wealth, its strength and standing before the world, but he has contributed to the national treasury all the costs of operation of the Patent Office, and, in addition, the aggregate sum of about $4,000,000, which now stands to its credit on the books of the treasurer of the United States. But even this would be a matter of minor importance had the services rendered the inventor been all that he could

ask, and thoroughly creditable to the country to which he gives such inconceivable advantages, and which he pays so exorbitantly besides. The Patent Office, built for his use, fifty-five years ago, when the business of the office was comparatively a mere trifle in magnitude and importance, is, to-day, entirely insufficient for his needs, even were he given its full use. But not only is he deprived of its use, he is not even allowed a fair share of his own building, the rooms of the General Land Office are compulsorily taken from his domain, and the Patent Office is crowded into corners and into the damp basements of its own building, to make room for the intruders, and this at a time when more than all is needed for its legitimate purposes.

Thus, with $4,000,000 accumulated out of its own earnings, with its quarters overcrowded and unhealthy, with the business of the nation dragging and necessarily seriously suffering, inventors waiting for their papers months where they should be easily served in days, with commissioner and examiners overworked, confined in uncomfortable and unhealthy quarters, and worried and poisoned at the same time, millions are voted for "improving" unknown creeks and never-heard-of "rivers," and are wasted by dishonest contractors and unskilled builders, while the inventor and the nation are allowed to suffer through the most marvelous indifference, or worse, of responsible legislators who neglect to give him scant justice and refuse to allow him even to use the building set apart, a half century ago, for his use, or to usefully employ the millions which he has put into the treasury over and above the thousands of millions that he has indirectly contributed to the national wealth.

There exists to-day no more crying wrong, among the many sins for which our inefficient government is answerable, than this sin against the inventors, and it is the duty of every good citizen to take up this matter and keep this wrong in view until the evil has been fully righted and the shameful ingratitude of our country fully condoned.

The first step should be to give to the Patent Office every foot of space that of right belongs to it; then to add, if necessary, double the space, to insure room for all the force that can be profitably worked, with well lighted offices, perfect ventilation, ample and safe storage for documents, and for the library; which latter should be as absolutely complete in its field as it can possibly be made. Nothing that can add to the promptness and efficiency with which the business of the office is transacted should be left undone. The nation will profit, and profit enormously, by every step that it may take in this direction. Let us take care of the inventor, treating him fairly and liberally, and we may be sure that the progress which the last century has seen will appear insignificant in comparison with that of the coming centuries. He will repay all that is done for him many times over.

In these days, when one is so often tempted to lament the apparent decay of patriotism, statecraft, and generous appreciation of our greatest benefactors, one turns with a sense of delightful refreshment to that famous "Report on Manufactures" written by Alexander Hamilton, in 1791, and especially to Section VIII., in which he outlines desirable methods of "encouragement of new inventions and discoveries at home," and the care and protection of "authors and inventors." Could we to-day have but one Hamilton in Congress, and a few earnest followers distributed throughout the country, to leaven this great mass, such a state of affairs as now exists in the national Patent Office would not long continue. It is to be wished that every reader of the SCIENTIFIC AMERICAN may find time to read, with care and thought, this remarkable report of Hamilton, and then turn his attention as a first step in a good cause to the cleansing of our Augean stables and the securing of justice for the inventor and his friends in the Patent Office. R. H. THURSTON.

Ithaca, N. Y., January 15, 1892.

PRESERVING THE COLORS OF FISH AND OTHER ANIMALS.

MR. HALY, Curator of the Colombo Museum, has for some years been making experiments so as to discover a medium which will preserve the colors of fish and other animals. The following is from the last annual report of the Colombo Museum:

"In my last year's report I made some remarks on the use of carbolized oil as a mounting fluid for specimens already prepared by other means, the idea that it was a preservative in itself not having occurred to me. Further experiments this year seem to show (I do not like to speak too confidently in a climate like this, even with twelve months' experience) that it is one of the most perfect preservatives known both for form and color.

"Cocoanut oil and carbolic acid freely mix in all proportions. The mixtures at present under trial are oil raised to the specific gravity of 10° and 20° below proof spirit by the addition of acid. While the gum and glycerine process is absolutely useless for any animals except certain families of fish, this mixture is good for every kind of vertebrate. The most delicate frogs are quite uninjured by it, and snakes undergo no change. The delicate plum-like bloom on the geckoes, the fugitive reddish tint on such snakes as *Ablabes humberti*, are beautifully preserved by it.

"Another most important use is in the preservation of large fish skins, which can be packed away in it for an indefinite period, and mounted when wanted. These kinds do not require varnishing, neither do they turn brown, but although, of course, they do not preserve their sheen like fish in the oil itself, they always maintain a silvery and natural appearance, quite different from that of ordinary museum specimens. If ever we get a new fish gallery, a show of our large species prepared in this way would form a most effective exhibition.

"It appears also to be a most excellent preservative for crustacea and the higher orders of arachnids, and also for centipedes, but it has hitherto proved a failure for marine invertebrates in general. It must be remembered, however, that the perfect miscibility of the two liquids opens endless possibilities. Its absolutely unevaporable nature makes it invaluable in a tropical climate, quite apart from its other qualities.

"With regard to this last remark, I take the opportunity of stating that the acid enables cocoanut oil and turpentine to be mixed together. This forms a splendid microscopic fluid, in which objects may be allowed to soak without any previous preparation, and in which they become very transparent. A minute species of crustacean, of the order Copepoda, and the leg of a fly, simply laid on a slide in a drop of this fluid and covered with an ordinary covering glass, without any cell being made or cement employed, have lain on my table unaltered for the last ten months, and I cannot help thinking that such a medium as this cannot fail to prove a great boon to all workers with the microscope."

THE SANITARY INSTITUTIONS OF PARIS.

AMONG the public services of the city of Paris that concern hygiene and public assistance, there are some of recent installation that present a manifest interest from the standpoint of charity and of the sanitary state of the city, and also from a scientific point of view. These are the night refugees, the disinfecting stations and the ambulance stations, which are under the jurisdiction of the Prefecture of the Seine.

We shall, in passing them successively in view, endeavor to justify the interest that these institutions seem to us to merit.

Night Refuges.—It suffices to have seen, were it but once, the long files of unfortunates who formerly awaited the hour of entrance into the municipal night refuges, to appreciate the necessity of having such establishments in so great an agglomeration as that of Paris. The right of asylum has at all times been the appanage of the holders of public office. In a democracy like ours, this right must be exercised in its plenitude, but it may be legitimately tempered by the necessary guarantees against the abuse that might be made of it.

It is not for us to study here this difficult and complex problem; this is not the place for it. Let it suffice for us to say that the asylum offered to a needy person can be but momentary, provided he is neither infirm nor sick, but is still healthy. The charity bestowed upon him must always be considered as a transient relief that permits him to get out of trouble. A provident assistance should not be invested with the character of an almsgiving.

Three municipal refuges now exist in Paris—two for men, on Quai Valmy and Chateau-des-Rentiers Street, and one for women, on Fessart Street. There are others projected, which will doubtless soon be constructed, for those in operation hardly satisfy the demands at certain times of the year. It will be remembered that last year, during the course of the winter, which was very severe, it became necessary to multiply the number of these provisional asylums, and even to use a portion of the unoccupied galleries of the Champ de Mars.

The Fessart Street asylum is a workhouse refuge exclusively designed for women out of work. The duration of the stay therein is, at a maximum, three months. During this time the women are given lodging, food, clothing, and laundering, but they are obliged to do various kinds of work, such as sewing, laundering, etc. By turns, hours of exit are accorded to them in order to permit them to seek work. Among them there are young women, either *enciente* or having babies. We know, in fact, how much difficulty such women experience in getting work, whether they have abandoned the country in order to be delivered in the great city, or have been sent away from the place that they occupied.

The two refuges for men are occupied only at night, and only three nights consecutively by each of those who come to ask hospitality therein. A man cannot return until two months after this period of three days. The cards of admission, good for the night, are delivered all day long for as many places as the asylum contains. Each of these establishments thus nightly puts two hundred beds at the disposal of the destitute who have neither place of shelter nor money; but the number daily received amounts, in reality, to 240 persons on an average.

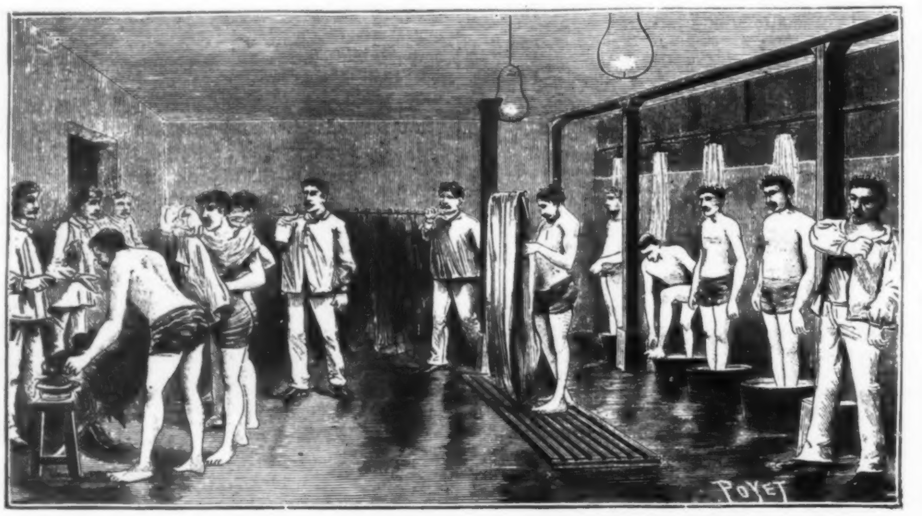

FIG. 1.—BATH HALL IN THE QUAI VALMY REFUGE.

The refuges consist essentially of a reception office, bath halls, dining halls, and dormitories, together with various annex halls. Fig. 3 shows the general arrangement of one of these establishments, that of Quai Valmy, to which is likewise annexed, as on Chateau-des-Rentiers Street, a disinfecting station (figured to the left in the plan), which we shall speak of hereafter.

After entering the gate, which opens at nightfall, and crossing court No. 1, the person seeking shelter awaits his turn to enter, in a building situated at the spot marked 2. Then he enters the passageway that runs along the reception office. Here he must give his name, address, trade, and other information proper for proving his identity, such as workman's or soldier's "livret," and then he goes immediately through the corridor 4 to the bath hall 7, where he divests himself of his clothing (Fig. 1). After leaving this on a bench, he must cover all parts of his body with carbolic soap, put at his disposal by the agents, who watch all these operations with the greatest care. Then he places himself under an apparatus that showers him with warm water. During this he stands in a tub filled with warm water. The cleaning and showering of all parts of the body having been effected, the man puts on a shirt, a pair of trousers, and a vest, furnished by the establishment. During this time his clothing and linen of all kinds have been carried to the disinfecting station. The next morning, on rising to leave the refuge, the man exchanges these borrowed effects for his own, which have been cleaned and disinfected.

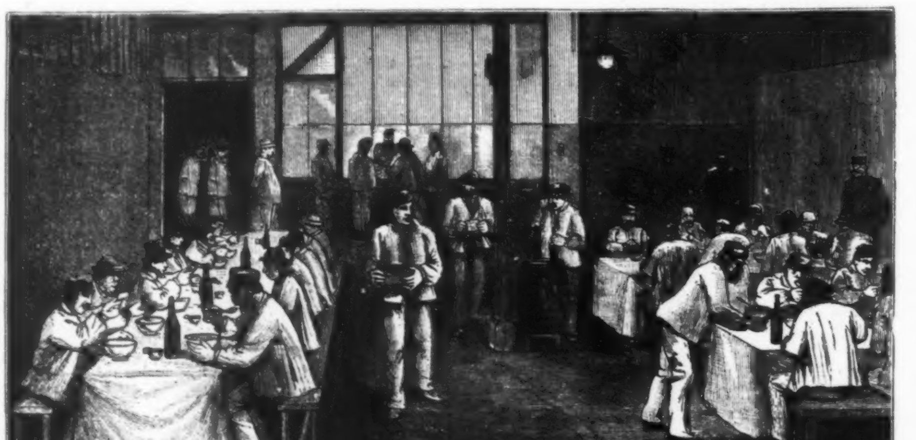

FIG. 2.—DINING HALL.

This done, the man passes through the corridor (6), and, in front of the wicket of the kitchen (5), receives his portion of food, which he goes to the dining hall (8) to eat at the tables arranged therein (Fig. 2). For each man, the rations are, at night, a quart of soup of bread and vegetables, and, in the morning, on leaving, a piece of bread weighing about ten ounces. As a beverage he receives water to which has been added a little gentian and licorice.

Thus washed and fed, the beneficiary betakes himself to one of the dormitories (No. 9, Fig. 3), where he lies down upon one of the beds arranged in rows of twenty-five in large structures heated in winter and aerated in summer. He finds here an iron bedstead provided with a mattress, a bolster, sheets, and a blanket, which are kept in a perfect state of cleanliness. The springs of these beds are of a new and interesting arrangement. They are formed of a metallic frame in which is stretched a thick cord rolled several times and forming a sort of lattice work. The elasticity of the system is excellent, its cleanliness easily assured, and its net cost extremely low.

If we add to these various structures the lodge of the keepers (No. 12), the lodge of the superintendent of the water closets (No. 10), which have to be carefully looked after, and the storerooms, we shall have traversed all the parts of this establishment, which are kept perfectly clean and are very carefully managed, and are combined with a view to utility rather than to architectural beauty, which would be much out of place, for here every resource must be employed for rendering the greatest assistance possible to the victims of fate.

A few statistics will prove the importance of such establishments.

The refuge of Bucherie Street, now destroyed for the opening of Monge Street, was founded in 1886. Up to the time of the closing of it, it had, in three years and a half, received 45,680 persons.

In three years, the Chateau-des-Rentiers Street refuge received 50,369 persons. The Quai Valmy refuge has given aid to 125,752 beneficiaries, say 24,017 in 1887, 30,452 in 1888, 25,094 in 1889, 24,435 in 1890, and 21,776 in 1891. The general total gives 221,801 persons thus received, which represent 665,403 nights passed in these establishments since their creation.

Let us add that last year 181,437 persons were admitted into the provisional refuges installed during the severe portion of that exceptional winter.

The number of the beneficiaries varies very little each month in each of these asylums, for they are almost always full.

One is singularly astonished, when he glances over the list of avocations of the persons who knock at the door of these establishments, to see how many people there are (outside of day laborers, men in trouble and journeymen, who form the majority) who have had relatively favorable situations, and even some who have practiced more or less lucrative professions. The cosmopolitan population that frequents them is generally needy. Criminals avoid such assemblages, and the *declassés* shun them as much as possible. It is not one of the least of the sorrowful pictures of the struggle for existence that unfolds itself in these asylums where so many unfortunates crowd together. They must be pitied, in fact, for although there are some among them who, to the profit of their indolence, appear to speculate in the municipal charity, those are exceptions, and the great majority really have need of this momentary asylum. These latter do not always remain even the three nights allowed by the regulations, and some have been enabled, owing to such aid, to regain the strength necessary to obtain again the work that they had just got out of, or to get together the means to permit them to return to the country that they ought not to have left. Of those received at the Quai Valmy refuge in 1890, 1,163 were thus enabled to return home.

One of the peculiarities that first strikes the visitor to these asylums is the large number of letters that cover the windows of the office of admission, awaiting their owners, who do not fear to give this as their address, just as if it were a question of some hotel. Those to whom these letters belong are usually unfortunates who have already been in the asylum one or two days, and have corresponded in answer to their requests for employment. In some cases, the letters have been addressed to persons who have already left the establishment. In rare cases it is a question of individuals who carry the precaution so far as to foresee a long time in advance that they will some day use the hospitality of the city again. However this may be, the municipality through these refuges renders signal service to a large portion of the population. In this, it is aided by the able and intelligent direction given to these establishments by Mr. Menant.—*La Nature.*

EXPERIMENTAL RESEARCH ON TINNED PEAS, GREENED WITH SULPHATE OF COPPER, AND THE PHYSIOLOGICAL ACTION OF THIS SALT ON ANIMALS.

By M. CHARTERIS, M.D., Professor of Therapeutics and Materia Medica, University of Glasgow; and WM. SNODGRASS, M.B., C.M., Muirhead Demonstrator of Physiology, University of Glasgow.

WE received for the purpose of this research four tins of peas from the sanitary authorities of Glasgow on Dec. 1 last, and on the same day commenced our examination of these on the following lines: 1. To determine that copper existed in the samples of peas we had obtained. 2. To find out their digestibility when placed in solutions similar to those of (*a*) gastric and (*b*) pancreatic juices, and also the digestibility of albuminate of copper in the same solutions. 3. To ascertain the physiological action of sulphate of copper on animals. Under these headings we will now give details of our experiments.

1. A tablespoonful of peas was taken from a tin which had been kept for ten minutes in boiling water and placed in a glass mortar. They were then acidulated with a little hydrochloric acid and crushed to a pulpy consistence by a glass pestle.

The mass was then transferred to a platinum crucible and a zinc rod inserted through it, so as to touch the bottom of the crucible. A distinct deposit of copper was observed on the crucible, when, after the expiration of four hours, it was emptied and washed.

2. A tablespoonful of peas from the same tin, after being masticated, was placed in a glass vessel containing 4 oz. of water. To this were added 0·7 per cent. of pepsin and 0·2 per cent. of dilute hydrochloric acid. A tablespoonful of peas from the same tin was also masticated, placed in a vessel containing the same quantity of water, and to this was added a solution of pancreatin and carbonate of sodium. Both vessels were put on a sand bath and a uniform temperature of 99° F. maintained. At the end of an hour in the case of the gastric solution, and after an hour and a half the pancreatic solution, was tested for peptone by the biuret test. In both cases a distinct red color was observed, thus showing that digestion had taken place. A control experiment, in which no digestion had taken place, similarly tested, showed only a violet color. The filtered fluid from the gastric solution was tested for copper by the insertion of a steel knife. After three hours this was taken out, and a distinct deposit of copper was observed on both sides of the blade. Mr. Tatlock, analyst for the city of Glasgow, testifies "that when an ounce of coppered green peas in a solution of ten grains of a peptonizing powder and ten ounces of water is digested, the copper is dissolved out to the extent of 0·52 grain per lb. of the peas, which is equal to 2·05 grains of crystallized sulphate of copper." Mr. Clarke's analysis indicates a similar result.

Doubtless sulphate of copper, however administered by the mouth, forms in the stomach an albuminate of copper which is rendered soluble by the digestive process. Yet as some strong statements have been made denying the possibility of this occurring, we now resolved to try the digestibility of an artificial albuminate of copper made (*α*) from white of egg and a weak solution of sulphate of copper, (*β*) made from curdled milk and a weak solution of sulphate of copper. These albuminates were dried, and a piece of each about the size of a lentil was placed in (*α*) solutions of pepsin and hydrochloric acid, (*β*) solutions of pancreatin and carbonate of sodium. The solutions were placed on a sand bath, and a temperature of 99° F. maintained.

Egg albuminate of copper.—Evidence of digestion commenced almost immediately in the acid solution, the blue color first gradually disappearing, and at the end of one hour and ten minutes the digestion was complete. In the alkaline solution the disappearance of the blue color was also observed, but the digestion was longer—viz., two hours.

Casein albuminate of copper.—With this albuminate the rapidity of the process was reversed, for it was completed in an hour in the alkaline solution, and at the expiration of two hours in the acid solution. Neither of these albuminates dissolved in strong acids, and this obvious fact has been by some observers brought forward as a test of their insolubility.

3. *Physiological action of sulphate of copper on animals.*—On Dec. 8th a full-grown rabbit was put into a basket, and a piece of bread spread with a paste of albuminate of copper was placed beside it. No other food was given. On the 9th the animal had eaten the greater part of the bread, and we calculated had taken seven grains of sulphate of copper. It was sickly, refused food, and dragged its hind extremities when it attempted to cross the room. The same day it was killed, the liver and kidneys taken out, cut up into small pieces, and two ounces of water and one drachm of sulphuric acid were added to the comminuted organs. Heat was applied for half an hour, and the fluid was filtered.

A portion of this fluid was placed in a platinum crucible, and heat was used until the organic matter was burnt off. Strong nitric acid was added to the residue until it became of a pasty consistence, and a distinct deposit of copper was observed on the top of a steel knife which was placed in it. On Dec. 11 a full-grown rabbit was fed with greens over which a solution of sulphate of copper, seven grains to the ounce of water, was sprinkled, the greens being subsequently dried. By the next day the animal had taken the greater part of the greens. It was sickly and refused food, and did not move about easily. On the same day it was killed, and the organs similarly treated as in the former experiment. A copper deposit was also observed on a steel knife placed on the paste after the organic matter had been burnt off, and the residue treated with nitric acid. Into a portion of the filtrate kept for this purpose a needle was inserted, and at the expiration of twenty-four hours a deposit of copper was observed. The needle was again inserted and withdrawn after forty-eight hours, when it was found to be completely covered with copper.

We were so far satisfied with the results which accrued from its administration when given to rabbits, as these evidenced its absorption into the system; but as

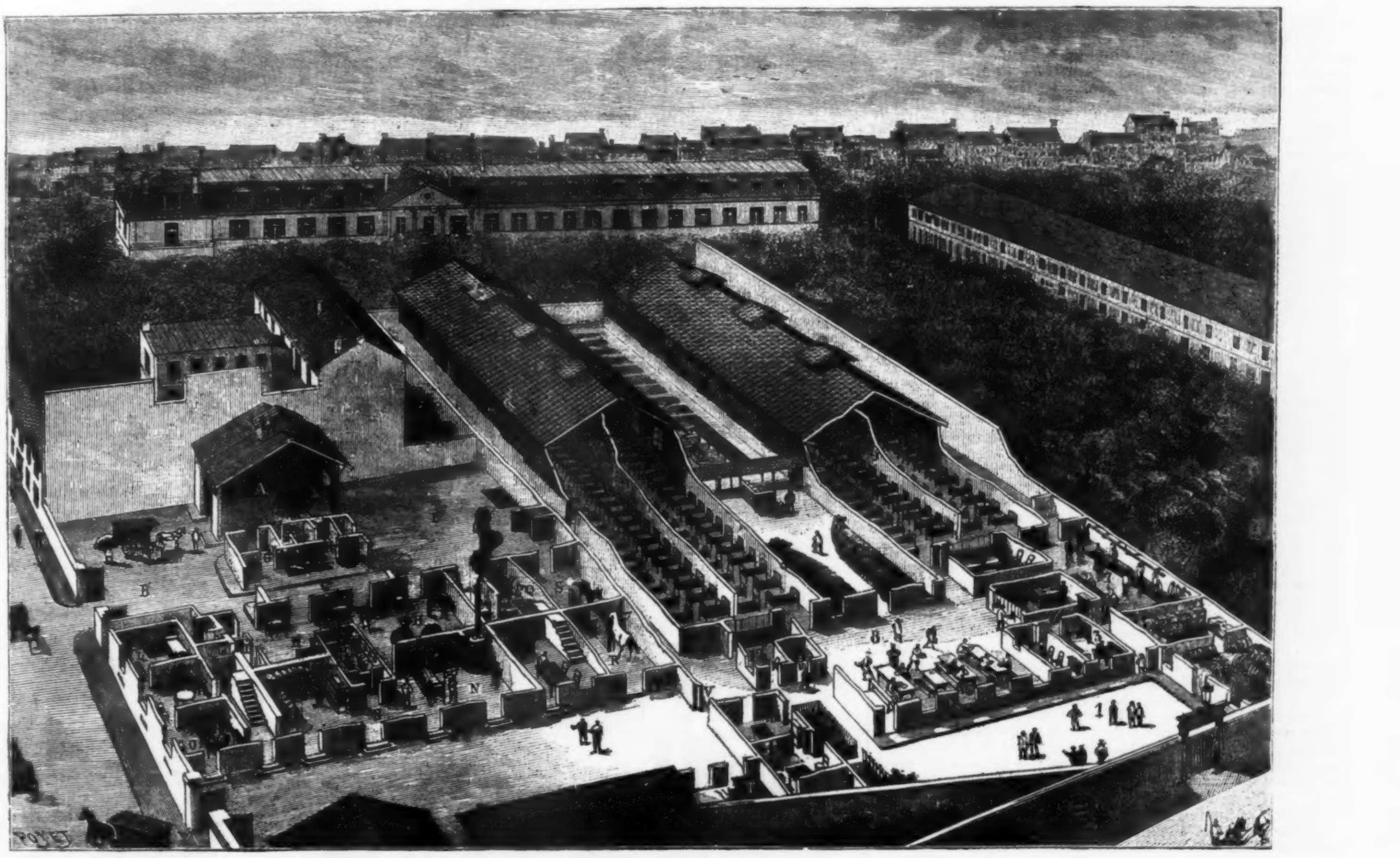

FIG. 3.—NIGHT REFUGE OF QUAI VALMY AND DISINFECTING STATION, GENERAL VIEW.

these animals are rather dainty in regard to their food, we resolved to try its action on a pig, which, as every one knows, will swallow almost anything placed before it. As our time was somewhat limited, we gave sixty grains of the sulphate of copper in milk and meal to a young pig weighing nine pounds; but, contrary to our expectations, the animal refused this food for twenty-four hours. Therefore, on Dec. 12 we made a weaker solution (ten grains to the ounce of water), and when this quantity was added to the milk and meal it was taken easily. The same quantity, ten grains, was taken for four days, and then the animal was killed. The liver and kidneys were boiled with water and strong sulphuric acid, and a knife was placed in the filtrate. At the end of eighteen hours the knife showed, to the extent of its immersion, two inches, a complete covering of copper on both sides. The evidence of experiments 1, 2, and 3 was shown in court and their significance explained to Sheriff Birnie, who tried the case at the instance of the sanitary authority of Glasgow. The evidence for the prosecution and the defense is fully and correctly given in the *Chemist and Druggist*, in its issues of Jan. 1 and Jan. 15. A careful reading of each shows that the evidence for the defense in no way traversed what we had done, and which was supplemented by such well known chemists as Messrs. Tatlock and Clarke. Yet, in deciding for the defense, the sheriff stated that "no new evidence had been brought forward." By his decision he sanctioned the use of a strong irritant metallic poison in food intended for consumption by human beings, the amount of which is not fixed, but is left to the discretion of foreign manufacturers over whom the authorities of our country have no control.—*The Lancet.*

CARPET BEATING.

THE destruction of morbific germs in order to prevent the propagation of epidemics has been practiced from remote antiquity. The means employed for this purpose consisted for the most part in burning the linen and effects that belonged to the deceased, and sometimes even the house that he lived in or all the houses in which the scourge had made its appearance. Such a process, by far too radical, and, we may say, far too barbarous, did not, however, always yield the results that were expected, because it could scarcely be applied except when the epidemic had assumed a general character that robbed this method of all its efficacy. The progress that has since been made in our knowledge of these diseases and of the way in which they are propagated has permitted of establishing preventive measures which, although they do not always prevent an epidemic from breaking out at such or such a point, yet sometimes permit of confining it to such places and of creating almost insurmountable barriers to it. Besides, as we could not think seriously of setting the four corners of a city on fire in order to destroy the miasms due to an epidemic disease, an earnest effort has been made to find a means of annihilating the action of such miasms without having recourse to the violent process of destruction. Among such means, those most used are washing with antiseptic liquids for dwellings and treatment by disinfecting stoves for garments and personal effects. But, aside from the diseases called epidemic, science has made known others whose propagation is likewise effected by way of contagion, without, however, the action of the germ being sufficiently rapid, in most cases, to conceal its origin. Among such diseases, that which has attracted most attention in recent times is undoubtedly tuberculosis. The numerous scientists who have studied this terrible scourge are unanimous in regarding it as of a contagious nature. Nothing is commoner than to see one or more persons living in a room in which a consumptive has died, and in which minute precautions have not been taken to destroy the morbific germs, attacked by the disease, and that, too, a long time after the decease of the first subject.

Farther, the labors of Messrs. Cornet and Pransnitz have established the fact that it does not require a lengthy cohabitation with a tuberculous subject, nor a prolonged stay in a room where the latter has been attended, for a person to be attacked by the disease.

In fact, Mr. Pransnitz has shown that a trip in the compartment of a railway car in which a consumptive has ridden suffices to communicate the germ of the disease to the traveler. This he discovered by collecting the dust contained in the coaches running from Berlin to Meran, a station frequented by a large number of consumptives, and inoculated guinea pigs with it after Cornet's method, by peritoneal way. Out of five coaches submitted to experiment, two were found to contain the bacillus of tuberculosis. The dust of one communicated the tuberculosis to three out of the four guinea pigs inoculated, and that of the other two out of four. On another hand, Mr. Cornet has cited a case of tuberculous infection in a person that had lived in a hotel room in which a consumptive had died.

But how is the transmissibility of the bacillus produced? Here we are less positive, at least experimentally, but it appears very natural to suppose that the infection is due to the spitting of the invalids upon the carpets either of the railway coaches or living rooms. It is therefore this part of the furnishing of rooms that should particularly attract attention. It is this too that is most difficult to clean, and this explains the fact that people are very often content, after a death has taken place, to simply sweep or imperfectly beat the carpet.

The processes employed up to the present for the beating of carpets are based upon the use of rods or leather thongs manipulated by hand or actuated mechanically. The violent and repeated blows that the carpets receive in this way soon tear the seams and injure the fabric, and, despite everything, are inadequate to completely expel the dust.

It is in order to remedy all such inconveniences that has been devised the system represented in our engravings, and the operation and advantages of which we are going to point out to our readers. Fig. 2 shows the arrangement of the works in which the beating is done. The carpets are unrolled and spread out on the floor, whence two men take them and fix them to a drum formed of a series of horizontal iron rods placed quite close to each other and fixed upon the circumference of two pulleys mounted upon a shaft actuated by gearings. This drum is almost completely surrounded by a wooden cage of prismatic form, which leaves but a narrow passage on each side for the introduction and exit of the carpet. Over the drum, which is represented on a larger scale in Fig. 1, runs a pipe, A, provided beneath with a series of nipples, C, which nearly reach the carpet, D. The conduit, A, contains air compressed to a pressure varying from 5 to 10 atmospheres. This air, escaping through the nipples, strikes the carpet with great force during its passage over the drum, and passes through it and carries along all the particles of dust that are contained in the fabric. The compressed air comes from a reservoir, A (Fig. 2), through a system of pipes, B, which cause it to traverse an iron vessel, C, where it becomes charged with antiseptic substances. From thence it flows into the conduit, B, from which start the branches that distribute it throughout the entire length of the pipe located in the cage of the drum.

After the carpet has entirely passed through the apparatus, the drum's motion is reversed and two workmen standing on each side fix it anew to the drum, and so on, until the dust has been completely expelled. The air thus charged with dust and miasms is sucked

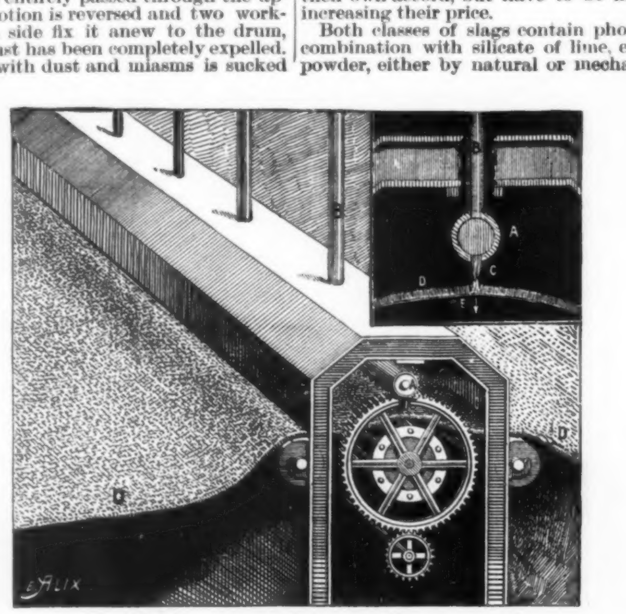

FIG. 1.

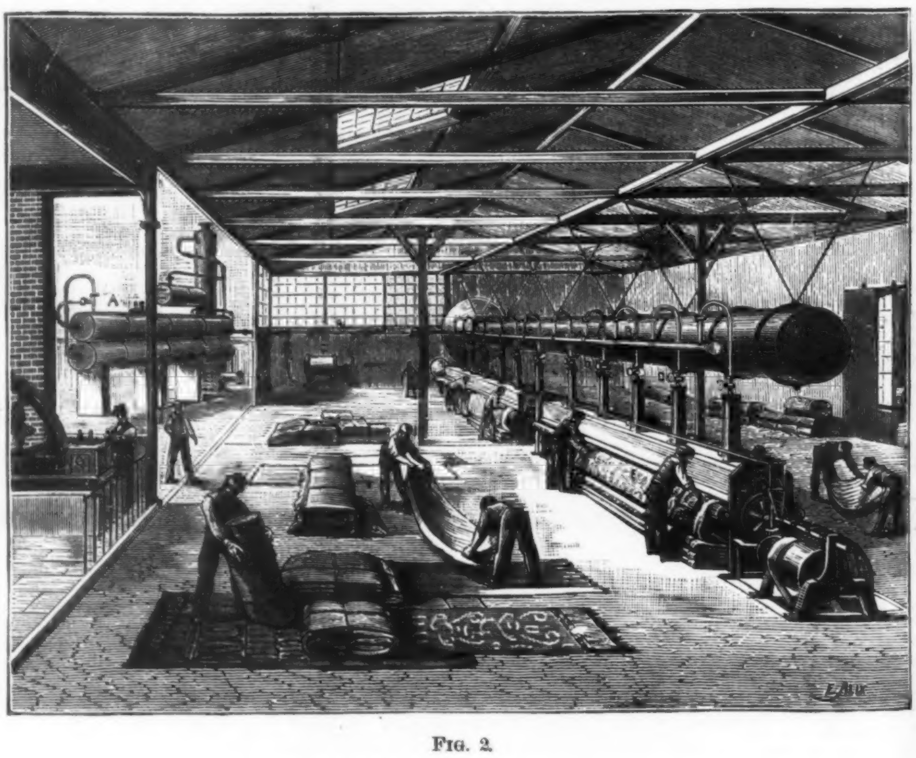

FIG. 2.

A CARPET BEATING ESTABLISHMENT.

out beneath the carpet by an exhauster, which sends it into a series of depositing chambers containing vertical partitions, where it is gradually cleansed, the dust falling upon the floor, and the air finally escaping through a chimney situated at the extremity of the last chamber.

It will be seen that, through this arrangement, the beating, while being undoubtedly more complete than in the older systems, can do no injury to the fabric, and that it destroys for the most part the morbific germs spoken of above.—*Les Inventions Nouvelles.*

AGRICULTURAL USE OF THOMAS SLAG.

By M. JOULIE.

THE following remarks upon the use of Thomas slag were made by M. Joulie at the Agricultural Congress at Versailles.

The slags produced at works which do not work the acid Bessemer plant according to the process of Messrs. Thomas and Gilchrist contain little, if any, phosphoric acid, and ought, in consequence, to be rejected for manurial purposes.

Even when the genuine Thomas slag is obtained it is divided into two classes, one containing excess of lime and the other not.

The former of the two, namely, that having excess of lime, only contains about 12% of phosphoric acid, but it disintegrates readily under the influence of moisture, on account of the excess lime which it contains becoming hydrated, swelling through its combination with the water, so that it completely assumes a finely divided state. Thus, there being no need to grind these slags, they are sold at a low price, and afford a cheap source of phosphoric acid. At the same time, since they are poor, they are not suitable for transport to a distance, but most advantageously employed in the neighborhoods surrounding the works where they are produced. The slags which do not contain an excess of lime are much richer, and are found to contain from 14% to 20% of phosphoric acid: but they do not disintegrate of their own accord, but have to be finely ground, thus increasing their price.

Both classes of slags contain phosphate of lime in combination with silicate of lime, etc. Reduced to a powder, either by natural or mechanical means, they are readily attacked in the soil by carbonic acid, which dissolves the phosphate of lime, thus assisting a state of molecular division, so that they are very easily assimilated.

On this account they can be used in the place of superphosphates. This, however, is only true for soil rich in organic matter, such as recently cleared forest land and garden soils, etc., because soils of this nature contain large quantities of carbonic acid, and, moreover, humic acid in abundance.

But in ordinary plowed land their action is generally much slower than superphosphates, while, in calcareous earths, their action is even wholly inappreciable. These slags are, therefore, specially suited for non-calcareous and highly organic soils, where they act rapidly, both their phosphoric acid and lime being utilized at once.

In soils which contain little organic matter, so long as they are not calcareous, they may be employed, though they are inferior to superphosphates. It is thus apparent that, for soils rich in lime, superphosphates are the only phosphatic manure that can be used with advantage.

In any case, these slags ought to be plowed in or

spread in the autumn, upon land which is lying fallow. They ought never to be mixed with superphosphates, which they deteriorate, neither with ammonium sulphate, from which they liberate nitrogen as ammonia, nor should they be allowed to sweat, for the same reason.—*Chem. Tr. Jour.*

ON THE RELATION OF NATURAL SCIENCE TO ART.*

By Dr. E. DU BOIS-REYMOND.

I.

WE are assembled to-day in annual commemoration of a man whose marvelous breadth of view and extraordinary variety of interests are each time a fresh surprise to us. It seems incredible that the same hand could have penned the "Protogea" and the state paper adjudging the principality of Neufchatel to the King of Prussia, or that the same mind could have conceived the infinitesimal calculus and the true measure of forces, as well as the pre-established harmony and the "Theodicea." A closer examination, however, reveals a blank in the universality of his genius. We seek in vain for any connection with art, if we except the Latin poem composed by Leibnitz in praise of Brand's discovery of phosphorus. We need hardly mention that his "Ars Combinatoria" has nothing to do with the fine arts. In his letters and works, observations on the beautiful are few and far between; once he discusses more at length the pleasure excited by music, the cause of which he attributes to an equable, though invisible, order in the chordal vibrations, which "raiseth a sympathetic echo in our minds." However, the world of the senses had little reality for Leibnitz. With his bodily eye he saw the Alps and the treasures of Italian art, but they conveyed nothing to his soul. He was indifferent to beauty; in short, we never surprise this Hercules at Omphale's distaff.

The same neglect, at least of sculpture and painting, strikes us in Voltaire, who as polyhistorian can in some measure compare with Leibnitz. We are obliged to descend as far as the third generation—that is, to Diderot in France, to Winckelmann and Lessing in Germany—before we meet with a decided interest in the fine arts, and an appreciation of the part they play in the progress of civilization.

The period thus defined, though it excels in science, shows with few exceptions a falling off in the fine arts. On considering the historical development of these two branches of human productiveness, we find no correspondence whatever between their individual progress. When Greek sculpture was in its prime, science scarcely existed. True, Lionardo's gigantic personality, which combines the immortal artist with the physicist of high rank, towers at the beginning of the epoch generally known in the history of art as the Cinquecento. Still, he was too far in advance of his age in the latter capacity to be cited as an example of simultaneous development in art and science; so little that Galilei was born the day of Michael Angelo's death. The mutual development of art and science at the commencement of our century is, I believe, merely a casual coincidence; moreover, the fine arts have since been at the best stationary, whereas science strides on victoriously toward a boundless future.

In fact, both branches differ too widely for the services rendered to science by art, and *vice versa*, to be other than external. "Nature," Goethe very truly observed to Eckermann, little thinking how harshly this remark reflects on part of his own scientific work, "Nature allows no trifling; she is always sincere, always serious, always stern; she is always in the right, and the errors and mistakes are invariably ours." Fully to appreciate the truth of this, one must be in the habit of trying one's own hand at experiments and observations, while gazing in Nature's relentless countenance, and of bearing, as it were, the tremendous responsibility incurred by the statement of the seemingly most insignificant fact. For every correctly interpreted experiment means no less than this: whatever occurs under the present circumstances, would have occurred under the same conditions before an infinite negative period of time, and would still occur after an infinite positive period.

Only the mathematician, whose method of research has more in common with that of the experimenter than is generally supposed, experiences the same feeling of responsibility in presence of nature's eternally inviolable laws. Both are sworn witnesses before the tribunal of reality, striving for knowledge of the universe as it actually is, within those limits to which we are confined by the nature of our intellect.

However, there is a compensation for the philosopher, laboring under this anxious pressure, in the consciousness that the slightest of his achievements will carry him one step beyond the highest reached by his greatest predecessor; that possibly it may contain the germ of vastly important theoretical revelations and practical results, as Wollaston's lines contained the germ of spectral analysis; that, at any rate, such a reward is not only in the reach of a born genius, but of any conscientious worker; and, finally, that science, by subduing nature to the rule of the human intellect, is the chief instrument of civilization. No real civilization would exist without it, and in its absence nothing could prevent our civilization, including art and its master works, from crumbling away again hopelessly, as at the decline of the ancient world.

This consciousness will also make up to the philosopher for the thoughtlessness of the multitude, who, while enjoying the benefits thus lavished upon them, hardly know to whom they owe them. The country rings with the name of every fashionable musical *virtuoso*, and cyclopedias insure its immortality. But who repeats the name of him who achieved that supreme triumph of the inventive intellect—to convey through a copper wire across far-stretching countries and over hill and dale the sound of the human voice as though it spoke in our ear?

"Life is earnest, art is gay;" this saying of Schiller's remains as true if we substitute science for life. Art is the realm of the beautiful; its productions fill us with an enjoyment, half sensuous, half intellectual; it is, therefore, a realm of liberty in the widest sense. No rigid laws are enforced in it, no stern logic binds the events of the present to those of the past and future, no certain signs indicate success, blame and praise are distributed by the varying taste of ages, nations, and individuals, so that the glorious Gothic church architecture came to be derided by the eighteenth century. In art, the definition of genius as a talent for patience does not hold good. Its creations, once brought forth in a happy hour of revelation, stir our souls with elementary force, and scorn all abstruse explanations, subsequently forced upon them by art criticism. Whoever accomplishes such a feat also ministers in a sense to the cares and troubles of humanity. Unfortunately the nature of things does not allow such fruit to ripen at all seasons. At one time, in one direction, the culminating point will be reached, and then age after age will strive in vain to emulate the past. The finest æsthetic theories can neither carry the individual beyond the limits of its own natural powers nor retrieve the fortunes of a declining period. Of what use has been the recent strife in the artistic world between naturalists and idealists? Has it protected us from the frequently almost intolerable extravagances of the latter? There is an attraction in every boldly advanced novelty which the common herd is unable to resist, and which will invariably triumph till antiquated ideas are somehow supplanted by fresh ones, or by the lofty rule of some irresistibly superior personality. Nor can science in the stricter sense come to the aid of art, and thus, strangers at heart, without materially influencing each other, each seeks its own way: the former advancing steadily, though irregularly; the latter slowly fluctuating like a majestic tide. Those unfamiliar with science are apt to recognize the supreme development of our mental faculties in art alone. Doubtless this is a mistake, yet human intellect shines brightest where glory in art is coupled with glory in science.

We may notice something here which is similar to what occurs in practical ethics. The more corrupt the morals of an age or nation, the more we find virtue a favorite topic. The flood of æsthetic theories rises highest when original creative power is at its lowest ebb. Lotze, in his "History of Æsthetics in Germany,"* gives a wearying and discouraging account of such fruitless efforts. Philosophers of all schools have rivaled in abstract definitions of the essence of beauty. They call it unity in multiplicity, or fitness without a purpose, or unconscious rationality, or the transcendent realized, or the enjoyment of the harmony of the absolute, and so forth. But all these properties, which are supposed to constitute the beautiful, have no more to do with our actual sensation of it than the vibrations of light and sound with the qualities they bring to our perception. Indeed, it would be vain to attempt to find one term equally fitted to describe all the varieties of the beautiful—the beauty of cosmos as contrasted with chaos, of a mountain prospect, a symphony, or a poem, of Ristori in Medea, or a rose; or even, taking the fine arts alone, the beauty of the Cologne Cathedral, the "Hermes" of Praxiteles, the Madonna Sistina, a picture of still life, a landscape, a genre piece, or a Japanese flower design, not to mention the questionable custom which permits us in German to speak of a beautiful taste or a beautiful smell. Let us rather admit that here, as so often, we meet with something inexplicable in our organization; something inexpressible, though not the less distinctly felt, without which life would offer a dull and cheerless aspect.

In an essay of Schiller's there is a disquisition on physical beauty.† He distinguishes between an architectural beauty and a beauty which emanates from grace. I attacked this æsthetic rationalism, to which the last century was strongly addicted, twenty years ago, on a similar occasion in a lecture on Leibnitz's ideas in modern science. I ventured to assert that "the attraction which physical beauty exerts on the opposite sexes can as little be explained as the effects of a melody."‡ On reflection, it seems, indeed, incomprehensible why one distinct shape, which, according to Fechner, might be represented by a plain algebraic equation between three variables, should please us beyond a thousand other possibilities. The reason can be traced from no abstract principle, no rules of architecture, not even from Hogarth's line of beauty. A year after this remark was made, Charles Darwin published his "Descent of Man," in which the principle of sexual selection, only cursorily treated in the "Origin of Species," is fully expounded, and pursued in all its bearings. I remember vividly how, in a discussion with Dove as to the necessity of admitting a vital force, he embarrassed me by the objection that in the organic world luxury occurs, for example, in the plumage of a peacock or a bird of Paradise, while in inorganic nature Maupertuis' law of the minimum of action precludes such prodigality. Here was a solution to the problem, allowing that one might attribute to animals a certain sense of beauty. The gorgeous nuptial plumage displayed by male birds may have been acquired through the preference of the female for more highly ornamented suitors, a progeny of constantly increasing brilliancy of coloring being thus obtained. Male birds of Paradise have been observed to vie in showing off their beauty before the females in courtship. The power of song in nightingales might be attributed to the same cause, the female in this case being more susceptible to the charms of melody than to those of brilliant coloring. Darwin goes on to observe that, in the human race likewise, certain sexual characteristics, such as the imposing beard in man and the lovely tresses in woman, might have been acquired through sexual selection.§ It is a well known fact that, by the repeated introduction of handsome Circassian slaves into aristocratic Turkish harems, the original Mongol type in many cases has been remarkably ennobled. And carrying the same principle further, we may find therein an explanation for the fascination which female beauty has for man. According to our present views, the first woman was not made of a rib taken out of the first man—a process fraught with morphological difficulties. It was man himself who, in countless generations, through natural selection, fashioned woman to his own liking, and was so fashioned by her. This type we call beautiful, but we need only to cast a glance at a Venus by Titian, or one by Rubens—let alone the different human races—to recognize how little absolute this beauty is.

If one kind of beauty could be said to bear analyzing better than another, it is what might be termed mechanical beauty. It is noticed least, because it escapes all but the practiced eye. This kind of beauty may belong to machines or physical apparatus, each part of which is exactly fitted to its purpose in size, shape and position. It answers more or less to the definition of "unconscious rationality," our satisfaction evidently proceeding from an unconscious perception of the right means having been employed to combine solidity, lightness, and, if necessary, mobility, with the greatest possible profit in the transmission of force, and the smallest waste of material. A driving belt is certainly neither attractive nor unattractive; but it pleases the "*visus eruditus*" to see a connecting rod thicken from the ends toward the middle, where it has to bear the greatest strain. Of course this kind of beauty is of recent origin. I remember Halske telling me that, as regards the construction of physical and astronomical instruments, it was, to his knowledge, first understood and established as a principle in Germany by Georg von Reichenbach in Munich. Berlin and Munich workshops produced instruments of perfect mechanical beauty at a time when those supplied by France and England were still often disfigured by aimlessly ornamented columns and cornices, unpleasantly recalling the impure features of Rococo furniture and architecture.

I forget which French mathematician of the last century, in sight of the cupola of St. Peter's at Rome, tried to account for the sense of perfect satisfaction it gives to the eye. He measured out the curves of the cupola, and found that, according to the rules of higher statics, its shape supplies the exact maximum of stability under the given circumstances. Thus Michael Angelo, guided by an unerring instinct in the construction of his model (the cupola was not erected till after his death), unconsciously solved a problem the true nature of which he could hardly have understood, and which was even beyond the reach of the mathematical knowledge of his age. Apparently, however, there are several roots to this equation of beauty; at least there is one other type, for which I quote the cupola of Val de Grace, in Paris, which, if not as imposing, is quite as gratifying to the eye, as Michael Angelo's.

It will be observed that in this case mechanical beauty becomes part of the art of architecture; and instances of this kind are daily growing more frequent, our modern iron structures being more favorable to its display than stone buildings. In the Eiffel Tower we see mechanical beauty struggling with the absence of plastic beauty. On this occasion it was probably revealed for the first time to many who hitherto had no opportunity of experiencing its effect. It is certainly not wanting in the new Forth Bridge. There is no doubt, however, that in stone structures, too, together with much that pleases from habit or tradition, there are certain features which evidently attract through mechanical beauty—such as the outline of the architectural members of a building, or the gentle swelling and tapering of the Doric column toward the top, and its expansion in the echinus and abacus; and there are others which offend a refined taste through the absence of this beneficial element, such as the meaningless ornamentations of the Rococo style.

Even in organic nature mechanical beauty prevails to such an extent that it transforms many objects into a source of delight and admiration to the initiated, which are naturally repulsive to the untrained eye. Anatomists recognize it with pleasure in the structure of the bones, especially of the joints. In their opinion the "Dance of Death" outrages good taste from more reasons than because it differs from the classical conception of death. Mechanical beauty was already perceived by Benvenuto Cellini in the skeleton, much to his credit; and but for our imperfect knowledge, it would invest with its glory every organic form, down to the inhabitants of the aquarium, even under the very microscope. According to Prof. Schwendener, even plants are constructed on the same principle of fitness combined with thrift; and something of this we feel at sight of a spreading oak tree proudly distending its vigorous branches toward air and sunlight.

Again, our appreciation of the forms of animals, especially of noble breeds, is greatly influenced by mechanical beauty. The greyhound and the bulldog, the full-bred race horse and the brewer's dray horse, the Southdown and the merino sheep, the Alpine cattle and the Dutch milch cow, all are beautiful in their kind; even though a bulldog or a Percheron may appear ugly to the uninitiated, because in each the type of the species has been modified to the utmost degree of fitness.

Though science is unable, as we have seen, to check the occasional decline of art and inspire it with fresh vigor, yet it renders invaluable services of a different kind to artists, by increasing their insight, improving their technical means, teaching them useful rules, and preserving them from mistakes. I do not allude to anything so primitive as the manufacture of colors or the technique of casting in bronze; the less so, as, curiously enough, our modern colors are less durable than those of entirely unscientific ages, and the unsurpassed thinness of the casting of Greek bronzes is regarded as a proof of their authenticity. Nor does it seem necessary to recall the notorious advantages of this kind for which art is indebted to science. Linear perspective was invented by Lionardo and Durer—artists themselves. It was followed by the laws of reflection—unknown to ancient painters, as would appear from the Pompeian frescoes of Narcissus—and by the geometrical construction of shadows. The rainbow, which had better not be attempted at all, has been sinned against cruelly and persistently by artists, in spite of optics. Statics furnished the rules of equilibrium, so essential to sculptors. Aerial perspective, again, owes its development to painters chiefly of northern climates.

But to this fundamental stock of knowledge the pro-

* An address delivered by E. du Bois-Reymond, M.D., F.R.S., at the annual meeting of the Royal Academy of Sciences, of Berlin, in commemoration of Leibnitz, on July 3, 1890. Translated by his daughter. This address was first printed in the weekly reports (*Sitzungsberichte*) of the Berlin Academy, then in Dr. Rodenberg's *Deutsche Rundschau*, and lastly it was published as a separate pamphlet by Veit & Co., at Leipzig, 1891.—*Nature.*

* Munich, 1868.

† "Ueber Anmuth und Wurde."

‡ The author's "Collected Addresses," etc., vol. i., pp. 49, 50, Leipzig, 1886.

§ The author is not unaware of Mr. Wallace's attack on Darwin's explanation of the brilliant plumage of male birds by the female's preference and of the discussion arisen between him and Messrs. Poulton, Pocock and Peckham. This was not the proper place to enter into it, the less so as, whatever may be its outcome, the author's conclusion from the theory of sexual selection would remain unaltered.

gress of science has added various new and important acquisitions, which philosophers, some of first-rate ability, have endeavored to place within the reach of artists. The great masters of by-gone ages were taught by instinct to combine the right colors, as women of taste, according to John Muller, always know how to blend the right shades in their dress; and Oriental carpet weavers have not been behindhand with them in that respect. But the reason why they unconsciously succeed was not revealed till the elder Darwins, Goethe, Purkinye, John Muller and others, called into existence a subjective physiology of the sense of sight. A member of this academy, Prof. von Brucke, in his "Physiology of Colors"* and "Fragments from the Theory of the Fine Arts in Relation to Industrial Art," † treats these subjects with such intimate knowledge as could only be obtained by one who enjoyed the rare advantage of combining physiological learning with an artistic education acquired in his father's studio. In France, Chevreul pursued similar aims. Even Prof. von Helmholtz, in his popular lectures, has devoted his profound knowledge of physiological optics to the service of art, which already owes him important revelations on the nature of musical harmony. Among other things, he explained the relation between the different intensities of light in objects of the actual world and those on the painter's palette; and pointed out the means by which the difficulties arising therefrom may be overcome.‡ Thus painters, as von Brucke remarks, have it in their power to reproduce the dazzling effect of the disk of the sun by imitating the irradiation—a defect of our visual perception the true nature of which was recognized by von Helmholtz. An example of this, interesting through its boldness, is the lovely Castell Gandolfo in the Raczynski gallery.

There are so many and striking instances of such imperfections of the human eye that, notwithstanding its marvelous capabilities, von Helmholtz has observed that "he would feel himself justified in censuring most severely the careless workmanship of an optician who offered him for sale an instrument with similar defects, and that he would emphatically refuse to take it." The eye being the chief organ of artists, its defects are of great importance in art and its history, and artists would do well to inform themselves, not only on these defects in general, but more particularly on those which they, in their own persons, are subject to; for, as Bessel remarked of astronomical instruments, "an error once well ascertained ceases to be an error."

Our conception of the stars as stars, in the shape adopted symbolically by decorative art, is caused by a defect of the eye closely related to irradiation; stars being luminous spots in the sky without rays, as they actually appear to a privileged few. Prof. Exner, whose line of thought we shall repeatedly cross in the course of these reflections, justly remarks that to this imperfection the stars conferred by sovereigns as marks of distinction owe their origin, and star fishes their name, even since Pliny's time. The different varieties of halo, however, are more probably free-born children of our fancy—from the Byzantine massive golden disk down to the mild phosphorescence proceeding from holy heads and in Correggio's "Night" from the entire child, which illumines the scene with a light of its own. According to Prof. Exner, glories of the latter description are derived from the radiance which surrounds the shadow of one's own head in the sunshine on a dewy meadow, and which in fact has always been compared to halos in religious pictures. This phenomenon even misled Benvenuto Cellini into the pious delusion that it was a gift granted him individually from above, and a reflection of his visions, such as Moses brought down from Mount Sinai.§

Certain otherwise quite inexplicable peculiarities which disfigure the later works of the distinguished landscape painter Turner have also been traced to defects of the eye by Dr. Richard Liebreich.‖ Clouded lenses or a high degree of astigmatism might easily lead a painter to distort or blur objects he was copying from nature. Donders' stenopeic spectacles or cylindrical spectacles, as the case might be, would prove as useful to such an artist as concave glasses to the short-sighted.

The singularities of another English painter, Mulready, are accounted for by Dr. Liebreich through discoloration of the lens from old age. Another defect of the eye—color blindness—ought to be mentioned here, which in its milder forms is of frequent occurrence, and even belongs to the normal condition of the eye on the borders of the field of vision. It corresponds in the domain of hearing to the want of musical ear. Color blindness was known long ago, but has been inquired into with redoubled zeal latterly, partly with regard to its general connection with chromatics, partly on account of its serious practical consequences in the case of sailors, railway officials, and, as Dr. Liebreich adds, of painters. Both color blindness and want of ear are inborn defects, for which there is no remedy. A color blind artist is, however, better off than a musician without an ear, if such a one were imaginable, for, even if he neglected the modeling stick and the chisel, he might still seek his fortune in the designing of cartoons.

It is difficult to determine the particular point where optical knowledge ceases to be of use to artists. None will repent having studied the laws of the movement of the eyes, the difference between near and distant vision, and the observations on the expression of the human eye contained in John Muller's early work on "Comparative Physiology of Sight." Yet it must be admitted that a painter may paint an eye exceedingly well without ever having heard of Sanson's images, which cause the soft luster of a gentle eye as well as the fierce flash of an angry one; as little as the blue sky of a landscape painter will gain by his knowledge of the yellow brushes in every great circle of the heavenly vault which passes through the sun, a phenomenon which has remained unnoticed for countless ages, but has grown familiar to physiologists since Haidinger's discovery.

One point, however, where physicists seem to me not to have been sufficiently consulted, is the much-debated question of polychrome in ancient statues and architecture, and whether it should be adopted by modern art or not. Physical experiments teach that very intense illumination causes all colors to appear whitish; in the spectrum of the sun, seen immediately through the telescope, the colors vanish almost entirely, nothing remaining except a light yellow hue in the red end. As the colors grow whitish the glaring contrasts are softened, they blend more harmoniously. In the open air, therefore, our eye is not shocked by the scarlet skirt of the *contadina*, which recurs almost as invariably in Oswald Achenbach's Campagna landscapes, as the white horse in Wouvermanns' war scenes. The Greek statues and buildings may have looked well enough with their glaring decorations under the bright southern sky on the Acropolis or in the Poikile; in the dull light of our northern home, above all in closed rooms, they are somewhat out of place.

In another direction Wheatstone has added valuable information to the knowledge of painters and designers with his stereoscope. It demonstrates the fundamental difference which distinguishes binocular vision of near objects from monocular vision, as well as from binocular vision of objects so far removed that the distance between the eyes vanishes as compared with their distance. An impression of solidity can only be obtained by each eye getting a different view of an object, the two images being fused into one, so as to appear solid. A painter can therefore only express depth by shading and aerial perspective; he will never be able to produce the impression of actual solidity on his canvas. While Wheatstone's pseudoscope exhibits the unheard-of spectacle of a concave human face, Helmholtz's telestereoscope magnifies, as it were, the space between the eyes, and resolves a far-off range of woods or hills without aerial perspective into its different distances. Finally, Halske's stereoscope with movable pictures confirms old Dr. Robert Smith's explanation of the much-debated circumstance that the sun and moon on the horizon appear larger by almost a fifth of their diameter than when seen in the zenith, and reduces the problem to the other question: Why the vault of the sky appears to us flattened instead of hemispherical.

However, the almost contemporary invention of photography was destined to be of vastly greater importance to the fine arts. It had always been the dream of artists as well as physicists to fix della Porta's charming pictures—a dream the realization of which did not seem quite impossible since the discovery of chloride of silver. One must have witnessed Daguerre's invention, and Arago's report of it in the Chamber of Deputies, to conceive the universal enthusiasm with which it was welcomed. Daguerre's method, being complicated and of restricted application, was soon cast into the shade by the one still essentially practiced at the present day. However, it is worth recording that, when the first specimens, imperfect as they were, reached us from England, no one foresaw the immense success in store for Talbotypes; on the contrary, the change from silver-coated plates to paper impregnated with the silver salt was received with doubt, and considered a retrogression.

Thus photography entered on its marvelously victorious career. With respect to art it promptly fulfilled what Arago had promised in its name. It not only facilitated the designing of architecture, interiors, and landscapes, and rendered the *camera clara* unnecessary even for panoramas, but also furnished many valuable hints with regard to light and shade, reflection and *chiaroscuro*, and the general means of reproducing as closely as possible on a level surface the raised appearance of solid forms. A competent judge of both arts might find it an interesting task to ascertain what share photography has had in the origin of the modern schools of painting, and in the manner of impressionists and pleinairists. It further taught landscape painters to depict rocks and vegetation with geological and botanical accuracy, and to represent glaciers, which hitherto had been but rarely and never successively attempted. It caught and fixed the changing aspect of the clouds, though only yielding a somewhat restricted survey of the heavens. It aided portrait painters without exciting their jealously; for, unable to rival them in representing the average aspect of persons, it only seized single, often strained and weary expressions, rendering almost proverbial the comparison between a bad portrait and a photographed face; nevertheless it supplied them on many occasions with an invaluable groundwork, lacking nothing but the animating touch of an artist's hand.

However, the recent progress of photographic portraiture claims the attention of artists in more than one respect. Duchenne and Darwin called into existence a new doctrine of the expression of the emotions; the former by galvanizing the muscles of the face, in order to imitate different expressions, the latter by inquiring into their phylogenetic development in the animal series. Both presented artists with photographs which quickly consigned to oblivion the copies hitherto employed for purposes of study in schools of art, dating chiefly from Lebrun; even the sketches in Signor Mantegazza's new work on "Physiognomy and Mimics" will scarcely enter into competition. On Mr. Herbert Spencer's suggestion, Mr. Francis Galton subsequently solved by the aid of photography a problem which was previously quite as inaccessible to painters as the representation of an average expression to photographers. He combined the average features of the face and skull of a sufficient number of persons of the same age, sex, profession, culture, or disposition to disease or vice, in one typical portrait, which exhibits only those characteristic forms common to their various dispositions. This was effected by blending on one negative the faint images of a series of persons belonging to the same description. In the same manner, Prof. Bowditch, of Harvard Medical School, Boston, obtained the representative face or type of American students of both sexes, and of tramway conductors and drivers. In the latter instance, the intellectual superiority of the conductors over the drivers is plainly visible. How Lavater and Gall would have relished this!

Of course the average expression of a single person might be procured by similar means, if it were worth while summing up on the same plate repeated photographs of different expressions. Instantaneous photography, however, furnishes a welcome substitute for the average expression, by seizing with lightning swiftness the changing phases of the human countenance in their full vivacity. Here, again, pathology places itself at the disposal of art. M. Charcot has found that photographs of the convulsions and facial distortions of hysterical patients resemble our classical representations of the possessed. Raphael's realism in this respect is perhaps the most curious of all, being so much at variance with his idealistic nature. In the possessed boy of the "Transfiguration," a cerebral disease can be almost safely inferred from the Magendie position of the eyes; and the circumstance, recently observed in New York, that the left hand is depicted in a spasm of athetosis, would accord well with this diagnosis.*

II.

There is yet another direction in which art owes instructive disclosures to the progress of photography. In the year 1836, the brothers William and Edward Weber represented, in their celebrated work on the "Mechanism of the Human Locomotive Apparatus," a person in the act of walking, in those attitudes which, according to theoretical calculation, must occur successively during one step. Thence a strange fact became apparent. At the beginning and end of each step, while the body rests for a short time on both feet, the pictures agree perfectly with the ordinary way in which painters have been accustomed to represent walking persons. But during the middle of the step, while one foot is swinging past the other, the effect is highly eccentric, not to say ludicrous; the individual appears to be stumbling over his own feet like a tipsy fiddler, and nobody had ever been seen walking in such a way. On the last page of their book, the brothers Weber propose to test the correctness of their diagrammatic figures by the aid of Stampfer and Plateau's stroboscopic disks, in the shape of Horner's dædaleum,† which has, strange to say, returned to us from America as a new invention, under the name of "zoetrope" or even "vivantoscope;" but whether the proposal was carried out or not, does not appear.

However, William Weber lived to see his assertions thoroughly justified almost half a century later by instantaneous photography. It was first put into practice in 1872, by Mr. Eadweard Muybridge at the suggestion of Mr. Stanford, in order to fix the consecutive attitudes of horses in their different paces. The result was the same as in Weber's diagrammatic figures; pictures were obtained which nobody could believe to have seen in reality. On photographs of street life and processions the camera frequently surprised people in attitudes quite as odd as those attributed to them by the brothers Weber on theoretical grounds. The same is the case with the remarkable series of photographs of a flying bird during one beat of its wings, obtained by M. Marey with his photographic gun.

The explanation is known to be as follows: An object in motion, the speed of which varies periodically, leaves a deeper and more lasting impression on our mind in those positions which it occupies longest, while the impression is fainter and more fleeting in those through which it passes quickly. Apart from all knowledge of this law, a painter would never represent a Dutch clock in a cottage with the pendulum at the perpendicular, as every spectator would inquire why the clock had been stopped. The pendulum, having swung in one direction, necessarily stops for a moment while preparing to return in the other, and consequently its diverging position is more vividly stamped on our our minds than those during which it passes through its position of rest with a maximum of speed. Precisely the same thing occurs with the alternately swinging legs of a man during the act of walking; the body remains longest in the position in which both feet support it, and shortest in that during which one foot swings past the other. We therefore receive scarcely any impression from the latter series of attitudes. We imagine a walking person, and painters accordingly represent him, in the interval between two steps, with both feet touching the ground.

In the case of a running horse, however, particular circumstances intervene. However rapid the succession of instantaneous photographs, we never obtain the usual image of a racing horse such as it appears in large numbers in the print shops at the racing season, and such as we suppose we actually see in reality. It is different in the case of man; there, among pictures obtained methodically or by chance, which have, so to speak, never been perceived by the naked eye, some will always occur which agree with the usual aspect of a walking person. The difference consists in this, that in a racing horse the interval of time during which the fore-legs remain in complete extension does not coincide with that during which the hind legs are fully extended. Both these positions prevailing in our memory, they are subsequently blended into the traditional pictures of a racehorse, whereas instantaneous photography fixes them successively. Consequently the traditional picture is wrong, and exhibits the horse in a position through which it does not even transitorily pass.

In the year 1882, an illustrated American paper brought out a picture of a steeplechase, in which all the horses are copied from Muybridge's photographs, in attitudes only visible to a rapid plate. This ingenious sketch was communicated to us by Prof. Eder in Vienna, in a pamphlet on instantaneous photography, and a stranger spectacle cannot well be imagined. The correctness of these apparently wrong pictures can, however, be proved by realizing the idea originally suggested by the brothers Weber, and integrating into a general impression the periodical motion which has been resolved, as it were, into differential pictures. This is done by gazing in the dædaleum at a series of photographs taken at sufficiently brief intervals from an object in periodical motion, or illuminating or projecting it momentarily during its rapid flight past the eye. The latter method has been put into practice by Mr. Muybridge himself in his "zoopraxiscope," and

* Second edition, Leipzig, 1867.

† Leipzig, 1877.

‡ Prof. von Helmholtz, "Collected Essays and Addresses," vol. ii, Brunswick, 1884.

§ "Vita di Benvenuto Cellini, scritta da lui medesimo," libro primo, cxxvii.

‖ "Turner and Mulready: the Effect of Certain Faults of Vision on Painting," etc. London, 1888.

* Sachs and Petersen, "A Study of Cerebral Palsies," etc., *Journal of Nervous and Mental Diseases*. New York, May, 1890.

† *Philosophical Magazine*, January, 1834, 3d Series, vol. ii., p. 36.

with us in the electric stroboscope by Mr. Ottomar Anschutz, a most skillful handler of instantaneous photography. In both instruments we see men and horses reduced to their natural mode of walking, running, or jumping—with one exception. The speed with which the slits of the dædaleum pass before the eye, or the period during which each picture is illuminated, being exactly the same for the whole series, the general effect produced is somewhat different from what it would be in real life. On the whole, however, the position in which both feet are touching the ground prevails, because the motion of the legs slackens when approaching this position, so that the pictures follow each other more closely and almost coincide.

The series of instantaneous photographs taken by Mr. Muybridge and Mr. Anschutz from an athlete, during the performance of a muscular effort, are an inexhaustible source of instruction to students of the nude. Mr. Anschutz's stroboscope exhibits a stone and a spear thrower in all the different stages of their violent action; their muscles are seen to swell and slacken, until finally the missile is represented after its discharge, as it cannot move any faster than the hand in the act of hurling it. Animal painters will find equally useful the instantaneous photographs which Mr. Muybridge and Mr. Anschutz have obtained from domestic and wild animals.

Even on breakers in a stormy sea the camera has been employed with surprising success. In making use of these photographs, painters should, however, remember that the human eye cannot see the waves as a rapid plate does, and beware of producing a picture which in certain respects would be quite as incorrect as the clock which appears to have been stopped, or the man stumbling over his own feet.

Finally, the traditional representation of lightning in the shape of a fiery zigzag has been recently proved by Mr. Shelford Bidwell, on the evidence of two hundred instantaneous photographs, to be just as wrong as the traditional picture of a racing horse. Mr. Eric Stuart Bruce endeavors to vindicate the zigzag by taking it for a reflection on cumulus clouds;* it is, however, difficult to understand how its sharp angles can be accounted for in this way.

Prof. von Brucke has devoted a special essay to the rules for the artistic rendering of motion, which, together with the laws on the combination of colors, have at all times been unconsciously followed by the great masters.

A cultivated and artistically gifted eye, supported by sufficient technical knowledge, was always able to compose genuine works of art in photography, as Mrs. Cameron long ago proved. In our days, Dr. Vianna de Lima has shown how this branch of art has been advanced and extended by instantaneous photography. It contributes a solution to Conti's question in Lessing's "Emilia Galotti"—whether Raphael, had he been born without hands, would not the less have been the greatest of painters. The photographic plate has been described as the true retina of the philosopher; and one might add, of the artist, if it were not unluckily almost color-blind. Unfortunately, theoretical reasons which experience will hardly contradict render it highly improbable that the expectations still entertained by artists and the general public, with regard to photography in natural colors, will ever be realized.

Whether photography does not act unfavorably on the reproductive arts, such as engraving, lithography, and wood cutting, by taking their place to an increasing extent, remains to be proved. Its fidelity is certainly such as, in a certain sense, to lower the value of the original drawings of the old masters, by making them common property. An exhibition, arranged by one of our art dealers several years ago, of the best engravings of the "Madonna della Sedia," together with a photograph from the original, first opened our eyes to the extent to which each master has embodied in his copy his own individual conception. But even were photography to cause such a retrogression in the reproductive arts, of what importance would that be, compared to the immeasurable services which, as a means of reproduction itself, it renders art, by disseminating the knowledge and enjoyment of artistic work of all kinds and periods? No one can fully estimate and appreciate what it has done to beautify and enrich our life, whose memory does not reach back into those, as it were, prehistoric times "when man did not yet travel by steam, write and speak by lightning, and paint with the sunbeam."

Is it credible, after all this, that there can be any need of mentioning the benefits derived by art from the study of anatomy? Has not the "Gladiator" of the Palazzo Borghese given rise to the conjecture that there were anatomical mysteries among the Greek artists, as the only means by which they could have obtained such complete mastery of the nude? Was it not through incessant anatomical studies that Michael Angelo acquired the knowledge necessary for the unprecedented boldness of his attitudes and foreshortenings, which are still a source of admiration to anatomists such as Prof. Henke and Prof. von Brucke? Has not provision been made by all governments that methodically encourage art, to afford to students an opportunity of training the eye on the dead subject to note what they will have to distinguish under the living skin? Have not three successive teachers, who afterward became members of this academy, been intrusted with this important duty in Berlin? Finally, do we not possess excellent compendiums of anatomy specially adapted to the use of artists?

And yet the most renowned English art critic of the day, who in his country enjoys the reputation and veneration of a Lessing, and who lays down the law with even more assurance—Mr. John Ruskin—explicitly forbids his pupils the study of anatomy in his lectures on "The Relation of Natural Science to Art,"† given before the University of Oxford. Even in the preface he deplores its pernicious influence on Mantegna and Durer, as contrasted with Botticelli and Holbein, who kept free from it. "The habit of contemplating the anatomical structure of the human form," he continues, "is not only a hindrance but a degradation, and has been essentially destructive to every school of art in which it has been practiced." According to him, it misleads painters, as for instance Durer, to see and represent nothing in the human face but the skull. The artist should "take every sort of view of animals, in fact, except one—the butcher's view. He is never to think of them as bones and meat."

It would be waste of time and trouble to refute this false doctrine, and to set forth what an indispensable aid anatomy gives to artists, without which they are left to grope in the dark. It is all very well to trust one's own eyes, but it is better still to know, for instance, how the male and female skeleton differ; why the kneecap follows the direction of the foot during extension, and not during flexion of the leg; why the profile of the upper arm during supination of the hand differs from that during pronation; or how the folds and wrinkles of the face correspond to the muscles beneath. Campe's facial angle, though superseded for higher purposes by Prof. Virchow's basal angle, still reveals a world of information. It is hardly conceivable how, without knowledge of the skull, a forehead can be correctly modeled, or the shape of a forehead such as that of the "Jupiter of Otricoli" or the "Hermes" be rightly understood. Of course fanciful exaggeration of anatomical forms may lead to abuse, as is frequently the case with Michael Angelo's successors; however, there is no better remedy against the Michael Angelesque manner than earnest study of the real. Finally, a superficial knowledge of comparative anatomy helps artists to avoid such errors as an illustrious master once fell into, who gave the hind leg of a horse one joint too many; or such as amuses naturalists in the crocodile of the Fontaine Cuvier near the Jardin des Plantes, which turns its stiff neck so far back that the snout almost touches the flank.

We are, however, less surprised at Mr. Ruskin's opinions, on learning that he similarly prohibits the study of the nude. It is to be confined to those parts of the body which health, custom, and decency permit to be left uncovered, a restriction which certainly renders anatomical studies somewhat superfluous. It is satisfactory to think that decency, custom, and health allowed the ancient Greeks more liberty in this respect. Fortunately, the English department of the Berlin International Exhibition four years ago has convinced us that Mr. Ruskin's dangerous paradoxes do not yet generally prevail, and that we are free to forget them in our admiration of Mr. Alma Tadema's and Mr. Herkomer's paintings. Nor could Mr. Walter Crane's charming illustrations, the delight of our nurseries, have been produced without disregard of Mr. Ruskin's preposterous doctrine.

In the same lecture Mr. Ruskin opposes with the utmost vehemence the theory of evolution and natural selection, and the æsthetic rule founded on it, according to which vertebrate animals should not be represented with more than four legs. "Can any law be conceived," he says, "more arbitrary, or more apparently causeless? What strongly planted three-legged animals there might have been! What systematically radiant five-legged ones! What volatile six-winged ones! What circumspect seven-headed ones! Had Darwinism been true, we should long ago have split our heads in two with foolish thinking, or thrust out, from above our covetous hearts, a hundred desirous arms and clutching hands, and changed ourselves into Briaren Cephalopoda."

Obviously, this false prophet has no notion of what in morphology is called a type. Can it be necessary to remind a countryman of Sir Richard Owen and Prof. Huxley that the body of every vertebrate animal is based on a vertebral column, from which it derives its name, expanding at one end into a skull, reduced to a tail at the other, and surrounded before and behind by two bony girdles, the pectoral and the pelvic arches, from which depend the fore and hind limbs with their typical joints? The very fact that palæontology has never known any form of vertebrate animal to depart from this type is in itself a striking argument in favor of the doctrine of evolution, and against the assumption of separate acts of creation; there being no reason why a free creative power should have thus restricted itself. So little will nature deviate from the type once given, that even deformities are traced back to it by teratology. They are not really monstrosities; not even those with a single eye in the middle of the forehead, which Prof. Exner takes to be prototypes of the cyclops, Flaxman being certainly mistaken in representing Polyphemus with three eyes—two normal ones which are blind, and a third in the forehead. Real monstrosities are those winged shapes of Eastern origin, invented by a riotous fancy while art was in its childhood; the bulls of Nimrud, the Harpies, Pegasus, the Sphinx, the griffin, Artemis, Psyche, Notos of the Tower of Winds, the goddesses of Victory, and the angels of Semitic-Christian origin. A third pair of extremities (Ezekiel even admits a fourth) is not only contrary to the type, but also irrational in a mechanical sense, there being no muscles to govern them. In the "Fight with the Dragon," Schiller has happily avoided giving his monster the usual pair of wings; and in Retzsch's illustrations its shape agrees so far with comparative anatomy as to recall a Plesiosaurus or Zeuglodon returned to life and changed into a land animal; indeed, the resemblance between those animals and the mythical dragon has led to the question whether the first human beings might not have actually gazed upon the last specimens of those extinct animal races.

An abomination closely related to the winged beasts are the Centaurs, with two thoracic and abdominal cavities, and a double set of viscera; the Cerberus and Hydra, with several heads on as many necks; and the warm-blooded Hippocamps and Tritons, whose bodies, destitute of hind limbs, end in cold-blooded fish—an anomaly which already shocked Horace. If they had at least a horizontal tail fin, they might pass for a kind of whale. The cloven-footed Faun is less intolerable; from him our Satan inherited his horns, pointed ears, and hoofs, on account of which Cuvier, in Franz von Kobell's witty apologue, ridicules him as an inoffensive vegetable feeder. The heraldic animals, such as the double eagle and the unicorn, have no artistic pretensions, and their historical origin entitles them to an indulgence they would otherwise not deserve.

It is a remarkable instance of the flexibility of our sense of beauty that, though saturated with morphological principles, our eye is no longer offended by some of these monstrosities, such as the winged Nikè and the angels; and it would perhaps be pedantic, certainly ineffectual, to entirely condemn these traditional and more or less symbolical figures, though in fact the greatest masters of the best epochs have made very slight use of them. There are, however, limits to our toleration. Giants, as they occur in our gigantomachia, with thighs turning half way down into serpents, which consequently rest, not upon two legs, but upon two vertebral columns ending in heads and endowed with special brains, spinal cords, hearts, and intestinal canals, special lungs, kidneys, and sense organs—these are, and always will be, the abhorrence of every morphologically trained eye. They prove that, if the sculptors of Pergamon surpassed their predecessors of the Periclean era in technical skill, they were certainly second to them in artistic refinement. Perhaps they should be excused on the plea that tradition bound them to represent the giants with serpent legs. The Hippocamps and Tritons, with horse's legs and fish tails, which disfigure our Schlossbrucke, date from a period in which classical taste still reigned supreme, and morphological views were still less widely diffused than at present. Let us therefore pardon Schinkel for designing or at least sanctioning them, as well as the winged horse and griffin on the roof of the Schauspielhaus, for which he must also be held responsible. But our indignation is justly aroused when a celebrated modern painter depicts with crude realism such misshapen male and female monsters wallowing on rocks or splashing about in the sea, their bodies ending in fat shiny salmon, with the seam between the human skin and the scaly cover scantily disguised. Such ultramarine marvels are worshiped by the crowd as the creations of genius; then what a genius Hollen-Breughel must have been!

Curiously enough, the inhabitants of the caves of Perigord, the contemporaries of the mammoth and musk-ox in France, and the bushmen whose paintings were discovered by Prof. Fritsch, only represented as faithfully as possible such animals with which they were familiar; whereas the Aztecs, a people of comparatively high civilization, indulged in fancies of more than Eastern hideousness. It would almost appear as if bad taste were associated with a middle stage of culture.

With regard to the teaching of anatomy in schools of art, the above proves that it should not be confined to human osteology, myology, and the doctrine of locomotion alone, but that it should also endeavor—and the task is not difficult—to familiarize the student with the fundamental principles of vertebral morphology.

Botanists should in their turn point out such violations of the laws of the metamorphosis of plants as must, no doubt, frequently strike them in the acanthus arabesques, palmettos, rosettes, and scrolls handed down to us from the ancients. From obvious reasons, however, these cannot affect them as painfully as malformations of men and animals, being in themselves repulsive to natural feelings, would the comparative anatomist. Moreover, a beneficial revolution has recently taken place in floral ornament. The displacement of Gothic art by the antique during the Renaissance had led to a dearth of ideas in decorative art. The rich fancy and naive observation of nature, displayed upon the capitals of many a cloister, had gradually given way to a fixed conventionalism, no longer founded on reality. Rauch, at Carrara, in search of a model for the eagles on his monuments, was the first to turn to a golden eagle, accidentally captured on the spot, instead of to one of the statues of Jupiter. It was then that, toward the middle of the century, decorative art began to shake off its fetters, and, combining truthfulness with beauty, returned to the study and artistic reproduction of the living plants with which we are surrounded. In this respect the Japanese had long ago adopted a better course, and to them we have since become indebted for many suggestions. Thus highly welcome additions were made to the decoration of our homes and the ornaments of female dress.

In one direction, however, it will be observed that men of science readily dispense with a strict observation of the laws of nature in art, at the risk of being charged with inconsistency. In works of art, both ancient and modern, flying and soaring figures occur in thousands. These, no doubt, sin against the omnipotent and deeply felt laws of gravity quite as much as the most loathsome creations of a depraved imagination against the principles of comparative anatomy, familiar only to a few adepts. Nevertheless they do not displease us. We prefer them without wings, because wings are contrary to the type, and could be of no use to them without an enormous bulk of muscle. But we do not mind the Madonna Sistina standing on clouds, and the subordinate figures kneeling on the same impossible ground. "Ezekiel's Vision," in the Palazzo Pitti, is certainly less acceptable. But to quote modern examples, Flaxman's "Gods flying to the aid of the Trojans," or Cornelius' apocalyptical riders, and Ary Scheffer's divine Francesca di Rimini, with which Doré had to enter into hopeless competition, are not the less enjoyable because they are physically impossible. We do not even object to Luini's representing the corpse of St. Catharine carried through the air by angels, or to that of Sarpedon, in Flaxman's drawing, by Sleep and Death.

In an interesting lecture on the "Physiology of Flying and Soaring in the Fine Arts," Prof. Exner endeavors to explain why illustrations of men and animals in this condition, though impossible and never visible in real life, strike us as familiar and natural. I do not profess to agree entirely with the position which he appears to prefer. His idea is that our sensations in swimming, and the position in which we see persons above us in the water when diving, are similar to what we would experience in flying. Considering what a short time the art of swimming has been generally practiced by modern society, especially by ladies, who, nevertheless, appreciate flying figures just the same, doubts arise as to the correctness of Prof. Exner's explanation. To attribute the feeling to atavism in a Darwinian sense, dating from a fish period in the development of man, seems rather far-fetched. And do not the sensations and aspect of a skater come much nearer to flying or soaring than those of a swimmer?

Another remark of Prof. Exner, which had also occurred to me, appears more acceptable. It is, that under especially favorable bodily conditions we expe-

* *Nature*, vol. xliii., pp. 151 and 197.

† "The Eagle's Nest. Ten Lectures on the Relation of Natural Science to Art." 1887.

rience in our dreams the delicious illusion of flying. For

"In each soul is born the pleasure
Of yearning onward, upward, and away,
When o'er our heads, lost in the vaulted azure,
The lark sends down his flickering lay,
When over crags and piny highlands
The poising eagle slowly soars,
And over plains and lakes and islands
The crane sails by to other shores."*

Who would not long, like Faust, to soar out and away toward the setting sun, and to see the silent world bathed in the evening rays of eternal light far beneath his feet? And when we long for anything, we love to hear of it, and to see it brought before us in image. Our desire to rise into the ether, and our pleasure in "ascensions" and similar representations, are further enhanced by the ancient belief of mankind in the existence of celestial habitations for the blessed beyond the starry vault; a belief which Giordano Bruno put an end to, though not so thoroughly but that we are constantly forgetting how badly we should fare, were we actually to ascend into those vast, airless, icy regions, which even the swiftest eagle would take years to traverse before alighting on some probably uninhabitable sphere.

We are now inclined to reverse the question, and to ask: What have sculpture and painting been able to do for science in return for its various services? With the exception of external work, such as the representing of natural objects, not much else than the results obtained by painters as to the composition and combination of colors, which, however, have not exercised as strong an influence on chromatics as music on

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acoustics. It is known that the Greeks possessed a canon of the proportions of the human body, attributed to Polycletes, which, as Prof. Merkel recently objected, unluckily only applied to the full-grown frame, to the detriment of many ancient works of art. The blank was not systematically filled up till the time of Gottfried Schadow. This canon has since become the basis of a most promising branch of anthropology—anthropometry in its application to the human races.

If the definition of art were stretched so far as to include the power of thinking and conceiving artistically, then, indeed, it would be easy enough to find relations and transitions between artists and philosophers, though, as we remarked at the beginning, their paths diverge so completely. But it is not so certain that natural science would necessarily be benefited by an artistic conception of its problems. The aberration of science at the beginning of this century known as German physio-philosophy owed its origin quite as much to æsthetics as to metaphysics, and the same erroneous principles guided Goethe in his scientific researches. The artistic conception of natural problems is in so far defective as it contents itself with well-rounded theoretical abstractions, instead of penetrating to the causal connection of events, to the limits of our understanding. It may suffice in cases where analogies are to be recognized by a plastic imagination between certain organic forms, such as the structure of plants or vertebrate animals; but it fails altogether in subjects such as the theory of colors, because it stops short at the study of what are supposed to be primordial phenomena, instead of analyzing them mathematically and physically. Prof. von Brucke subsequently, by the aid of the undulatory theory, traced to their physical causes the colors of opaques on which Goethe founded his theory of colors, and which to this day have tended rather to darken than to enlighten certain German intellects. The difference between artistic and scientific treatment becomes very evident in this example.

Nevertheless, it cannot be denied that artistic feeling may be useful to scientific men. There is an æsthetic aspect of experiment which strives to impart to it what we have termed mechanical beauty; and no experimenter will regret having responded to its demands as far as was in his power. Moreover, the transition from a literary to a scientific epoch in the intellectual development of nations is accompanied by a tendency to brilliant delineation of natural phenomena, arising from the double influence of the setting and the dawning genius. Instances thereof are Buffon and Bernardin de Saint-Pierre in France and Alexander von Humboldt in Germany, who, to his extreme old age, remained faithful to this tendency. In the course of time, this somewhat incongruous mixture of styles splits into two different manners. Popular teaching preserves its ornamental character, while the results of scientific research only claim that kind of beauty which in literature corresponds to mechanical beauty. In this sense, as I long ago ventured to indicate here on a similar occasion, a strictly scientific paper may, in tasteful hands, be made as finished a piece of writing as a work of fiction. To strive after such perfection will always repay the trouble to men of science; for it is the best means of testing whether a chain of reasoning, embracing a series of observations and conclusions, is faultlessly complete.

And this kind of beauty, which often graces, unconsciously and unsought for, the utterances of genius, will, no doubt, be also found to adorn Leibnitz's writings.

* Translation of Goethe's "Faust," by Bayard Taylor.

ORCHID HUNTING.

In the greedy quest for orchids at the present day, we have too often to regret a lamentable waste of opportunities on the part of some collectors. Not by any means that we would impute blame to those adventurous men who follow a calling in which the rate of mortality is among the very highest. They have certain allotted work to do, and that work is not, unless indirectly, the collection, still less the publication, of scientific information. They go for a definite purpose, which, for the most part, they execute with conspicuous success under most difficult and dangerous conditions. It is the system, not those who carry it out, that is to be reprehended. What a fund of information on all branches of natural history and geography might be accumulated, what treasures in the way of specimens might be got together, were the collectors able to turn their attention to other things besides orchids. If illustrations be wanted—illustrations which prove the rule—we may refer to the works of Hooper, of Fortune, of André, of Burbidge, or to the letters of John Veitch, published, like those of Fortune, in these columns. An account of the wanderings of Douglas was given in the *Companion to the Botanical Magazine*; that of Roezl in various foreign horticultural periodicals. These few instances will show that collecting and publication of observations are not necessarily incompatible, and that when fortunately they do coincide, while the world is vastly the gainer, the collector is at least none the worse.

Mr. Millican has just furnished us with another excellent illustration of the good work that a collector can do by publishing the record of his travels.* His book is "a narrative of things seen and experienced . . . . while traveling with natives through the forest, sharing with them the hospitality of the wayside hut or the forest shelter and the camp fire, as well as the more agreeable life of the hotels and towns." The narrative is founded on five journeys made to the orchid districts of South America (that is to say, the Venezuelan and Colombian districts).

The book is illustrated with woodcuts and process blocks, from photographs taken by the author himself. Some of these are excellent, and all are interesting. The earlier chapters traverse well-known and often described districts, but presently our author takes us to the valley of the Magdalena (of which we append an illustration from the pencil of the late A. Bruchmuller) and its tributaries, the Lebrija. A curious contrast is afforded by the town of Bucaramanga with its European luxuries, and evidences of advanced civilization, though high up on the Andes, and only accessible by canoe and mules.

From the town the author proceeded along the valley of La Florida in serch of Cattleya Mendelii. "On each side of the valley the mighty peaks of the Andes tower up to the clouds all bristling with forests." At Pie de Cuesta, 3,500 feet above the level of the sea, he speaks of the climatal conditions as furnishing twelve hours of day and twelve hours of night all the year round, a mild, balmy air which is never oppressively hot or disagreeably cold, an abundance of pure water, and a rich variety of tropical fruits. Here Epidendrum atropurpureum covers the walls, and flowers in profusion. A thousand feet higher the plain of La Mesa de los Santos is reached, and here we are told that the vegetation consists of a tall rank herbage with occasional scrub, intermingled with thousands of the beautiful Sobralia leucoxantha, with rose and white flowers of the color and substance of those of Cattleya Mendelii, but so difficult to transport that very few plants are known in England. Proceeding on his course, and leaving the precipices of Subi and the village of Curiti, he came at length upon the object of his search:

"I had not far to go before I was rewarded with the object of my search in the myraids of Bromeliaceæ and orchids, which literally covered the short, stunted trees and the bare points of rocks, where scarcely an inch of soil is to be found. The most magnificent sight for even the most stoical observer are the immense clumps of Cattleya Mendelii, each new bulb bearing four or five of its gorgeous rose-colored flowers, many of them growing in the full sun, or with very little shade, and possessing a glowing color which is very difficult to get in the stuffy hothouses where the plants are cultivated. Some of these plants, considering their size and the slowness of growth, must have taken many years to develop, for I have taken plants from the trees with 500 bulbs, and as many as 100 spikes of flowers, which, to a lover of orchids, is a sight worth traveling from Europe to see. Apart from the few extraordinary specimens, the orchids, as a rule, are very much crowded and mixed up with other vegetation."

Like most of his predecessors, Mr. Millican continues, he "was tempted to bear away a large quantity of the coveted plants," and so we may expect this habitat

* "Travels and Adventures of an Orchid Hunter: An Account of Canoe and Camp Life in Colombia while collecting Orchids in the Northern Andes." By Albert Millican. Cassell & Co. 8vo, pp. 222. Numerous illustrations.

will be denuded, as others have been before. For some reasons we shall be glad when the orchid fever abates, and the energy devoted to their acquisition is turned into some other channel.

Of Mr. Millican's further research for Odontoglossum crispum, the Alexandra orchid, we need say little here, but refer our readers to the book itself. We may add, however, that these orchids grow in an excessively wet climate, at an elevation of 7,000 to 8,000 feet, where they are exposed to a temperature which often falls as low in the night as 50°, and rarely, if ever, reaches beyond 60° in the day-time. Under such conditions, O. odoratum and O. crispum were found. After about two months' work, Mr. Millican secured 10,000 plants, cutting down to obtain these some 4,000 trees! Then the orchids had to be taken to the edge of the forest on men's backs, and even then they were five days' journey from the town of Pacho, where it is usual to make the boxes to pack the orchids in for shipment to England. Mules transport the boxes from Pacho to the banks of the Magdalena, and after ten days they reach the port of embarkation. Many of the plants die before they leave the coast, many more before they pass the West Indies; a few reach the Azores, a fewer still arrive in England safely. The statement just made applies more particularly to Odontoglossum blandum, but in a degree it applies to most of the orchids from whatever country they are introduced. At a lower elevation than that at which O. crispum is found in the neighborhood of La Palma, Cattleya Warscewiczii, C. labiata, Miltonia Phalænopsis, Oncidium Kramerianum, Masdevallia Harryana, Odontoglossum Pescatorei, Anguloa Clowesi, Odontoglossum blandum, and many others, are found. Another chapter tells of the search for Cattleya Trianæ, Miltonia vexillaria, Odontoglossum Harryanum, etc.

The risks attendant upon travel in the wilds are illustrated by the sad fate of one of the party, who was killed by a poisoned arrow, and the narrow escape from a jaguar on another occasion. In spite of drawbacks like these, Mr. Millican writes: "No pen or picture has or ever will be able to give more than a faint idea of the glories of this part of Colombia—of its riches in mines of emeralds and gold and silver; of its agricultural products of coffee, cocoa and grain; of its trackless forests, with their exhaustless supply of timber and choice woods, its wealth of ornamental and medicinal plants, its bevies of gaudy-colored birds and curious animals, its snow-capped mountains and boundless prairies, where the Indians have always roamed with perfect freedom; or of its commercial cities with their rich and cultivated inhabitants."—*The Gardeners' Chronicle.*

CHINESE WHITE WAX.

In the report of exports of native goods from Ichang for 1889 occur such items as 13,000 pounds of tigers' bones, valued at about £610, a price that precludes the idea that they are to be used as a fertilizer—the only use to which any one but a Chinese would think of putting them. As a matter of fact they are to be used as medicine, a sort of a tonic, which imparts to the invalid some of the tiger's strength. Another item is 9,000 pounds of "old deers' horns," worth £350. This is another medicinal article with whose peculiar properties the pharmacopœia of the West remains as yet unacquainted.

Perhaps the most interesting article of all, however, is "insect wax," of which 1,539,287 pounds were shipped from Ichang in 1889 in foreign ships. This immense quantity cost over 400,000 taels, or about £100,000 in gold. This "insect wax," or "white wax," is a product of the western part of the province of Se-Chuen and of parts of the adjoining province of Koei-Choo. It is, however in the Chion-chang valley, on the An-ning River, in Western Se-Chuen, that the wax insect most flourishes and finds its food most abundant. The whole subject of white wax was, by the direction of the English foreign office, thoroughly investigated by Mr. Hosie, her Majesty's consular agent at Shun-King, in Se-Chuen, and from his report thereon the following account is taken:

It seems that in Western China, not far from the Thibetan frontier, flourishes a tree called by the Chinese "evergreen tree."

It is, in fact, an evergreen with "leaves springing in pairs from the branches: they are thick, dark green, glossy, ovate, and pointed. In the end of May and beginning of June the tree bears clusters of small, white flowers, which are succeeded by fruit of a dark purple color." It has been classified by the authorities of the Kew Gardens as *Ligustrum lucidum.* Early in the spring there appear on the bark of the boughs and twigs of this tree numerous brown, pea-shaped scales. Upon opening these they are found to contain a mass of small animals, like flour, whose movements are almost imperceptible. These are the larvæ deposited by the white wax insect, whose scientific name is *coccus pela.* These shells or scales are gathered by the Chinese about the end of April, and carried to the prefecture of Chia-ting, the center of this industry, about 200 miles from the Chien-ch'ang valley. For this journey they are wrapped in packages, each containing about 16 ounces. The utmost care is taken to protect them from the heat, as the time of the development of the larvæ into insects is near at hand, and when this occurs they make their escape.

In the vicinity of the city of Chia-ting is a plain, described by Mr. Hosie as an immense rice field.

Almost every plat of ground on this plain, as well as the bases of the mountains, is thickly edged with stumps, varying from three or four to twelve feet in height, with numerous sprouts rising from their gnarled heads. These stumps resemble at a distance our own pollard willows. The leaves spring in pairs from the branches; they are light green, ovate, pointed, serrated and deciduous. The identity of this tree is uncertain, but it is supposed to be a species of ash, the *Fraxinus chinensis.* It is called by the Chinese "pai-la shu," or white wax tree.

The white wax scales, upon arrival, are made up into small packages wrapped in leaves, about twenty or thirty scales in each package, and suspended under the branches of the tree. Holes are punched in the leaves which constitute their covering, and the insects, on emerging from the scales, creep up the branches to the leaves of the tree, among which they remain thirteen days. They then descend to the branches and twigs, "on which they take up their positions, the females, doubtless, to provide for a continuation of the race by developing scales in which to deposit their eggs, and the males to excrete the substance known as white wax." It is supposed that the wax is intended by nature to protect the scales.

The first appearance of the wax on the under sides of boughs and twigs resembles snow, but it gradually spreads over the whole branch to the depth of one-quarter of an inch. At the expiration of 100 days from the placing of the insects on the wax tree the deposit is complete. The branches are then cut off. As much wax as possible is removed by hand, but, to secure what remains, the branches are afterward boiled. This boiling of the branches destroys the scales and their larvæ, thus necessitating the bringing of fresh scales the following year from another locality, as above described. A pound of scales, it is said, will produce four or five pounds of wax.

The wax scraped off is put into boiling water, where it melts, and, rising to the surface, is skimmed off and put into moulds. Here it solidifies, and the work of manufacture is complete. The insects, which have sunk to the bottom of the pot, are pressed out, and, when the wax has all been extracted from them, are fed to the pigs. A ton of this wax is worth at Shanghai about £200.

A tree from which the branches have been removed is not available again for three years. If the wax is left on the tree, the male insects buried under it undergo a metamorphosis, emerging with wings in the autumn and flying away.

This article, in contrast with the deers' horns and tigers' bones, above referred to, has an intrinsic value and not a fictitious one derived from fantastic ideas as to its medicinal qualities. It is, in fact, a substance of great utility, in common use in China. It is a clear white wax which melts only at a high temperature (160° F.), and is chiefly used to cover candles made of animal and vegetable tallow, to prevent too rapid combustion. It is used in some localities as a sizing for paper and cotton goods, a glaze for silk and polish for furniture. It is also said to be used in southern China as a polish for stone ornaments. The above figures of its export give only a partial idea of the proportions of the industry. Immense quantities are shipped from the ports of the Upper Yang-tse in Chinese junks, and some are sent across the mountains and via the West River to Canton. It is much used there, where thousands of pounds of it, in large round cakes, are stored away in a single room.

The introduction of foreign kerosene, now so universally used in China, has had a discouraging influence on the production of white wax. Kerosene lamps afford a cheaper light than tallow candles, and the constantly increasing use of oil diminishes the demand for wax. This affords but another example of the silent but ceaseless revolution which the entrance of foreigners into China has inaugurated in every branch of native trade. It is possible, however, that a use for this wax may be found abroad to re-establish the interesting and once flourishing industry.

THE GIANTESS ROSITA.

In Germany there is no lack of tall people; that is, people who measure from 5 ft. 7 in. to 6 ft. 7 in., but any who are taller than that are considered giants. Some years ago science assumed that gigantic proportions were attained only by the members of the male sex; the last few years, however, have demonstrated this to be a mistake, for during that time a large number of giantesses have been seen in public exhibitions. We have a new and striking proof of the fact that the "weaker sex" can do a great deal in the way of physical development, in the giantess Rosita, who has been exhibited in Berlin, where she caused much remark on account of her remarkable height, a little more than 8 ft., and weight of 350 pounds. She is, without doubt, one of the largest and heaviest women of the century. She was born in Vienna, March 25, 1865. Her parents, who are of normal size, are trades people living in a suburb of Vienna, while their daughter travels about to allow herself to be looked at. In the case of Rosita there is no question of inheritance of unusual height, as is often the case with giants. Her size is a freak of nature which science cannot explain.—*Illustrirte Zeitung.*

AN AUSTRIAN GIANTESS.

ACID, ALKALINE, AND NEUTRAL.

This is not intended to be a polemical contribution, and the three terms that make up the title are not intended to apply to persons who take one side, or the other side, or no side at all, in controversies relating to the management of ancient institutions. The terms acid, alkaline, and neutral are frequently used by photographers, and the conditions that they denote are of the utmost importance in many photographic operations. It is safe to say, however, that many photographers, and possibly not a few chemists also, fail to appreciate the full meaning of the terms, and are in the habit of using them somewhat loosely.

Confusion arises in the first place from the fact that the word "acid" is used in two senses; as a noun, to denote a particular class of compounds, and as an adjective to denote a certain quality or property that

is common to all the compounds in this class, but which they share with some other compounds belonging to different classes.

Then, again, proper distinction is not always made between a substance that is "alkali" (the word "alkali" being a noun) and a substance that is "alkaline" (the word "alkaline" being an adjective).

Most commonly the three terms are used with reference to the action of substances on certain coloring matters. Acid substances turn blue litmus to red; alkaline substances turn red litmus to blue. Alkaline substances turn yellow turmeric to brown, and the red coloring matter of red cabbage to green; acids restore the original color in either case. Substances that have these properties are said in the one case to be acid, or to have an *acid reaction*, and in the other case to be alkaline, or to have an *alkaline reaction*.

Now an acid is classed as such because it has certain distinctive properties, and in particular that of combining in definite proportions with bases to form salts, the acid being thereby neutralized. All acids have an acid reaction, and affect certain coloring matters in the manner described, but this power does not always disappear when the combining power of the acid is neutralized by a base. It is retained in a lower degree by the product of neutralization, or, in other words, by the salt that is formed. Similarly, when an alkali (which is a particular kind of base) combines with an acid, the alkaline reaction may disappear, but in not a few cases it persists in the salt that results from the combination.

In every-day language, every mare is a horse, but every horse is not a mare; so, too, every square is a rectangle, but every rectangle is not a square. Quite similarly, every acid has an acid reaction, but every substance that has an acid reaction is not an acid; every alkali is alkaline, *i. e.*, has an alkaline reaction, but every substance that has an alkaline reaction is not an alkali.

As already stated, substances are classed as acid, alkaline, or neutral, mainly according to their behavior with certain coloring matters, although we can distinguish between an acid *taste* and an alkaline *taste*. These coloring matters are termed *indicators*, and the particular indicator referred to in practically all cases is litmus. The progress of observation and experiment has, however, shown, in the first place, that there are other coloring matters that are as good, and, for some purposes, better, than litmus; and, in the second place, what is of greater importance, *the classification of substances into acid, alkaline, and neutral varies according to the particular indicator that is used*.

The three chief indicators now employed are as follows:

Litmus: Blue if alkaline, red if acid, purple if neutral; used in the form of a filtered solution of 20 parts of litmus in 1,000 parts of water; can be used with hot solutions.

Methyl Orange: Very pale yellow if alkaline or neutral, pink if acid; used in the form of a solution of one part of the solid in 1,000 parts of dilute alcohol; can be used with hot solutions.

Phenol Phthalein: Crimson if alkaline, colorless if neutral or acid; used in the form of a solution of two parts of the solid in 1,000 parts of dilute alcohol; must not be used with hot solutions.

Litmus and phenol phthalein can be used in the form of test papers, which are simply strips of pure paper, soaked in the solution of the indicator, and afterward dried.

A substance may be neutral to phenol phthalein, but alkaline to litmus, or neutral to methyl orange, but acid to litmus. The following table shows the behavior of the salts commonly used in photography toward the three indicators: Ac indicates acid, Al indicates alkaline, and N neutral:

	Litmus.	Methyl Orange.	Phenol Phthalein.
Alum	Ac	N	Ac
Ammonium bromide	N	N	N
Borax	Al	Al	N
Ferric chloride	Ac	N	Ac
Ferrous sulphate	Ac	N	Ac
Hypo (sodium thiosulphate)	N	N	N
Potassium bicarbonate	Al	Al	N
Potassium bromide	N	N	N
Potassium carbonate	Al	Al	Al
Potassium metabisulphite	Ac	N	Ac
Potassium oxalate	N	N	N
Silver nitrate	Ac	N	Ac
Sodium acetate	N	N	N
Sodium bicarbonate	Al	Al	N
Sodium carbonate	Al	Al	Al
Sodium citrate	Al	Al	N
Sodium metabisulphite	Ac	N	Ac
Sodium phosphate	N	Al	N
Sodium sulphite	Al	Al	N
Sodium potassium tartrate (Rochelle salt)	N	N	N

The possibility of confusion is increased by the fact that the terms "neutral" and "acid" are often applied to salts from the standpoint of their composition, without any reference to their behavior with indicators. An "acid salt" is a salt formed by the neutralization of only part of the combining power of an acid; *in composition* it is intermediate between the acid and the true salt, but *its reaction* may be acid, or neutral, or alkaline, according to the nature of the acid and base from which it has been formed. Sodium bicarbonate, for instance, is "acid sodium carbonate," but its reaction is alkaline to two of the indicators and neutral to the other; ordinary sodium phosphate is an "acid sodium phosphate," but its reaction is neutral to two of the indicators and alkaline to the other. The term "neutral salt" is often used (though, fortunately, the practice is becoming less common) as synonymous with "normal salt," which means a salt formed by the neutralization of the whole of the combining power of the acid. It so happens that in a large number of cases *the reaction* of a so-called "neutral" (*i. e.*, normal) salt is either acid or alkaline. Sodium and potassium carbonates are "neutral" or normal salts, but their reaction is alkaline to all three indicators. Alum, silver nitrate, copper sulphate, ferrous sulphate, and zinc sulphate are "neutral" or normal salts, but their solutions redden blue litmus even when they contain no free acid.

The first practical point is the importance of distinguishing between an alkali and an alkaline substance; between an acid, an acid salt, and an acid substance; and between a "neutral" salt (so called on account of its composition) and a substance that is really neutral. The second is the use of phenol phthalein for the detection of substances that are alkaline to it (such as sodium or potassium carbonate) in substances that are neutral to it, such as sodium or potassium bicarbonates or sodium sulphite.

The third is the use of methyl orange for the detection of free or uncombined acid in ferrous sulphate, zinc sulphate, copper sulphate, etc., which redden blue litmus paper even when they contain no free acid.

For scientific purposes it is always necessary, when we speak of a substance as acid, neutral, or alkaline, to specify the particular indicator that we are referring to.

The alkalinity chiefly employed in photography, as in alkaline developers, is alkalinity to litmus, and is, at the same time, as a rule, but not always, alkalinity to phenol phthalein.—*C. H. B., in Photography.*

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